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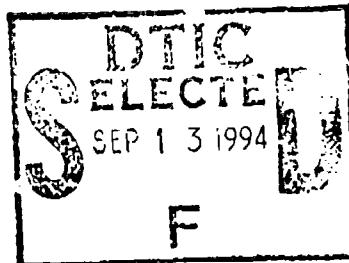
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## Rotorwash Analysis Handbook

### Volume II - Appendixes



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Final Report

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APPENDIX A  
MOTORCRAFT DESIGN DATA IN ROTWASH FORMAT

TABLE A-1 ROTORCRAFT DATA SUMMARY

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (pcr)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
<b>Aerospatiale</b>								
SA341G	3,970	17.25	1.5	4.24	1/3	683	8.9	--
SA342L	4,410	17.25	1.5	4.73	1/3	698	8.9	--
AS350B	4,299	17.55	2.0	4.44	1/3	698	10.3	--
AS350	4,960	17.55	2.0	5.12	1/3	698	10.3	--
AS355	5,600	17.55	2.0	5.79	1/3	698	10.3	--
AS355	5,291	17.55	2.0	5.47	1/3		10.7	--
SA315B	5,070	18.05	1.5	4.95	1/3		10.1	--
SA319B	4,960	18.05	1.5	4.84	1/3		9.8	--
SA360	6,615	18.85	2.0	5.92	1/4	690	11.5	--
SA365N	8,900	19.55	2.0	7.41	1/4	715	11.4	--
AS365	9,376	19.58	2.0	7.78	1/4	717	11.4	--
SA330	16,315	24.75	5.0	8.48	1/4	687	14.4	--
AS532 MK. I	19,840	25.60	5.0	9.64	1/4	711	15.0	--
AS532 MK. II	20,944	26.58	5.0	9.43	1/4		16.3	--
SA321	28,660	31.00	5.0	9.49	1/6	688	16.3	--
<b>Agusta</b>								
A109A	5,732	18.05	1.5	5.60	1/4	727	10.0	--
A109C	5,996	18.05	1.5	5.86	1/4	727	10.0	--
A129	9,039	19.52	2.0	6.80	1/4		10.5	--

TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (Pct)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
Bell								
47	2,850	18.50	1.0	2.65	1/2	645-716	9.5	--
206	3,200	16.65	1.5	3.67	1/2	688	9.5	--
OH-58A	3,200	17.65	1.5	3.26	1/2	654	9.5	--
OH-58D	5,500	17.5	1.5	5.72	1/4	724	8.5	--
206L	4,150	16.5	1.5	3.86	1/2	763	10.1	--
222B	8,250	21.0	4.0	5.95	1/2	765	10.8	--
230	8,250	21.0	4.0	5.95	1/2	765	12.0	--
204	8,500	22.0	2.0	5.59	1/2	746	11.8	--
UH-1M	9,500	22.0	2.0	6.25	1/2	746	11.8	--
205	9,500	24.0	2.0	5.25	1/2	814	11.8	--
212	11,200	24.0	2.0	6.19	1/2	814	13.4	--
412	11,900	23.0	2.0	7.16	1/4	780	11.0	--
214B	13,800	25.0	2.0	7.03	1/2	785	14.0	--
214ST	17,500	26.0	2.0	8.14	1/2	781	14.2	--
AH-1S	10,000	22.0	2.0	6.58	1/2	746	12.3	--
AH-1W	14,750	24.0	2.0	8.15	1/2	781	13.5	--
XV-15	13,200	12.5	13.0	13.44	2/3	771	12.5	32.2
Bell/Boeing								
V-22	47,500	19.0	10.0	17.63	2/3	790	20.1	46.5

TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (Pct)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
<b>Boeing/Vertol</b>								
CH-46E	24,300	25.5	7.0	5.95	2/3	705	16.6	33.3
CH-47C	46,000	30.0	8.0	8.13	2/3	723	18.6	39.2
CH-47D	54,000	30.0	8.0	9.55	2/3	707	18.6	39.2
<b>Instrument</b>								
F28F/28C	2,600	16.0	1.5	3.23	1/3	9.1	—	—
<b>Kaman</b>								
SK-2	12,800	22.0	2.0	8.42	1/4	687	13.6	—
<b>MBB</b>								
BO105CA	5,512	16.11	1.5	6.81	1/4	715	9.7	—
BO108	5,511	16.4	1.5	6.52	1/4	—	9.8	—
HK127	7,055	18.05	2.0	6.90	1.4	725	11.0	—
<b>McDonnell Douglas</b>								
300C	2,050	13.4	1.0	3.63	1/3	662	8.8	—
500D	3,000	13.2	1.5	5.48	1/4	665	8.5	—
500E	3,000	13.2	1.5	5.48	1/5	680	8.7	—
530F	3,100	13.7	1.5	5.28	1/5	684	8.7	—
AH-64	14,644	24.0	2.0	8.12	1/4	726	12.6	—
520N	3,350	13.67	1.5	5.71	1/5	684	8.7	—

TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (Pct)	Rotor Disk Loading (psf)	Number of Rotor Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
<b>Robinson</b>								
R22	1,370	12.6	1.0	2.75	1/2	699	8.8	--
R44	2,400	16.5	1.0	2.81	1/2	10.5	--	--
<b>Rogers/Hiller</b>								
UH-12	2,800	17.7	1.0	2.84	1/2	10.1	--	--
FH-1100	2,850	17.7	1.5	2.91	1/2	9.5	--	--
<b>Schweizer</b>								
300C	1,050	13.4	1.0	3.63	1/3	662	8.8	--
330	2,050	13.4	1.5	3.63	1/3	662	9.2	--
<b>Sikorsky</b>								
S-62	7,900	26.5	5.0	3.58	1/3	--	--	--
S-76	10,300	22.0	3.0	6.77	1/4	675	10.0	--
S-76B/C	11,700	22.0	3.0	7.69	1/4	675	10.0	--
UH-60A	20,250	26.85	3.0	8.94	1/4	725	12.3	--
UH-60L	22,000	26.85	3.0	9.71	1/4	725	12.3	--
S-61	20,500	31.0	5.0	6.79	1/5	17.0	--	--
SH-3	20,500	31.0	5.0	6.79	1/5	660	15.5	--
CH-3E	22,500	31.0	5.0	7.45	1/5	--	16.2	--
CH-54A	42,000	36.1	5.0	10.23	1/6	--	18.6	--
S-64E	42,000	36.1	5.0	10.23	1/6	--	18.6	--
CH-54B	47,000	36.1	5.0	11.54	1/6	700	17.6	--

TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (Pct)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
Sikorsky (Continued)								
CH-53D	36,400	36.1	5.0	8.89	1/6	700	17.0	--
HH-53	38,275	36.1	5.0	9.35	1/6	745	17.0	--
RH-53D	41,126	36.1	5.0	10.04	1/6	745	17.0	--
CH-53E	70,000	39.5	5.0	14.28	1/7	733	17.0	--
Westland								
Lynx	10,500	21.0	2.0	7.58	1/4	9.8	9.8	--
Lynx (3)	12,000	21.0	2.0	8.66	1/4	10.0	10.0	--
W-30-200	12,800	21.8	2.0	8.57	1/4	745	12.5	--
W-30-300	15,500	21.8	2.0	10.38	1/4	10.38	10.38	--
EH-101	31,530	30.5	5.0	10.78	1/5	21.3	21.3	--
SEA KING	21,500	31.0	5.0	7.12	1/5	660	15.5	--
MIL (Soviet)								
MI-8	26,455	34.93	5.0	6.90	1/5	16.0	16.0	--
MI-14	30,865	34.93	5.0	8.05	1/5	22.0	22.0	--
MI-17	28,660	34.93	5.0	7.48	1/5	15.5	15.5	--
MI-26	123,450	52.50	5.0	14.26	1/8	725	26.0	--
MI-34	2,976	16.41	2.0	3.52	1/4	16.0	16.0	--

**APPENDIX B**  
**SIKORSKY CH-53E HELICOPTER AND ROTWASH DATA**

Sikorsky CH-53E helicopter characteristics used with the ROTWASH analysis program are listed in table B-1 as obtained from reference B-1. Figure B-1 presents a three-view drawing of the helicopter. Table B-2 provides a summary tabulation of parameters defining the conditions for all rotorwash data presented in this appendix. Flight test data used in correlation with the ROTWASH calculated data are obtained from reference 2 and were measured along the 270-degree azimuth (out the left side of the helicopter). Distance from rotor center (DFRC), gross weight (GW), and rotor height above ground level (RHAGL) are the primary independent variables for these measured data. Discussion of results is presented in section 3.1 of this report.

**REFERENCES**

- B-1. Prouty, R.W., Helicopter Performance, Stability, and Control, Robert E. Krieger Publishing Company, Malabar, FL 32950, 1990.
- B-2. Harris, D.J., and R.D. Simpson, "CH-53E Helicopter Downwash Evaluation," Naval Air Test Center Technical Report No. SY-89R-78, August 1, 1978.

**TABLE B-1 CH-53E ROTWASH INPUT DATA**

<u>Parameter</u>	<u>Value</u>
Rotor radius, feet	39.5
Distance between rotor centers, feet	0.0
Airframe download, percent of rotor thrust	5.0
Distance from wheels to rotor plane, feet	17.0
Rotor speed, RPM	177.0
Rotor tip speed, feet/second	732.0
Number of rotor blades per rotor	7
Density ratio	1.0

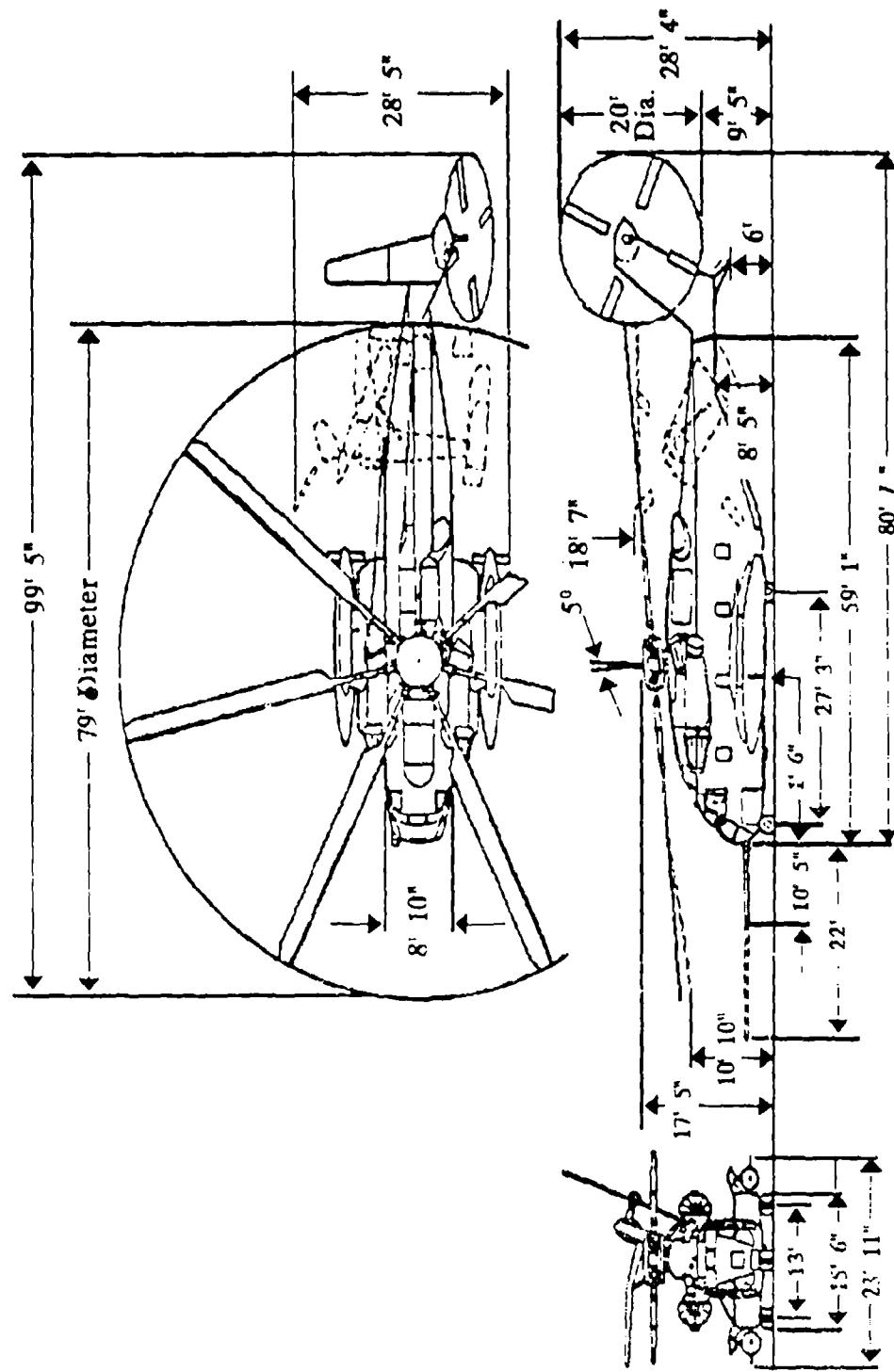


FIGURE B-1 THREE-VIEW DRAWING OF THE SIKORSKY CH-53E

TABLE B-2 EVALUATION MATRIX FOR CH-53E FLIGHT TEST  
MATHEMATICAL MODEL DATA CORRELATION

FIGURE NUMBER	GROSS WEIGHT (lb)	DISK LOADING (lbs/ft <sup>2</sup> )	ROTOR HEIGHT (feet)	DISTANCE FROM ROTOR CENTER (DFRC) (feet)
B-2	70,000	14.28	37.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-3	70,000	14.28	77.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.9
B-4	70,000	14.28	117.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-5	56,000	11.42	37.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-6	56,000	11.42	77.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-7	56,000	11.42	117.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-8	45,000	9.18	37.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-9	45,000	9.18	77.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-10	45,000	9.18	117.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8

NOTES:

- 1) The values of DFRC are only applicable along the 270-degree azimuth.
- 2) Ambient winds varied between 0 and 3.5 knots.
- 3) Atmospheric density ratio was assumed equal to 1.0 since pressure altitude (which was near sea level) was not documented in reference B-2. Ambient temperature was measured from 39 to 45 degrees Fahrenheit during testing.

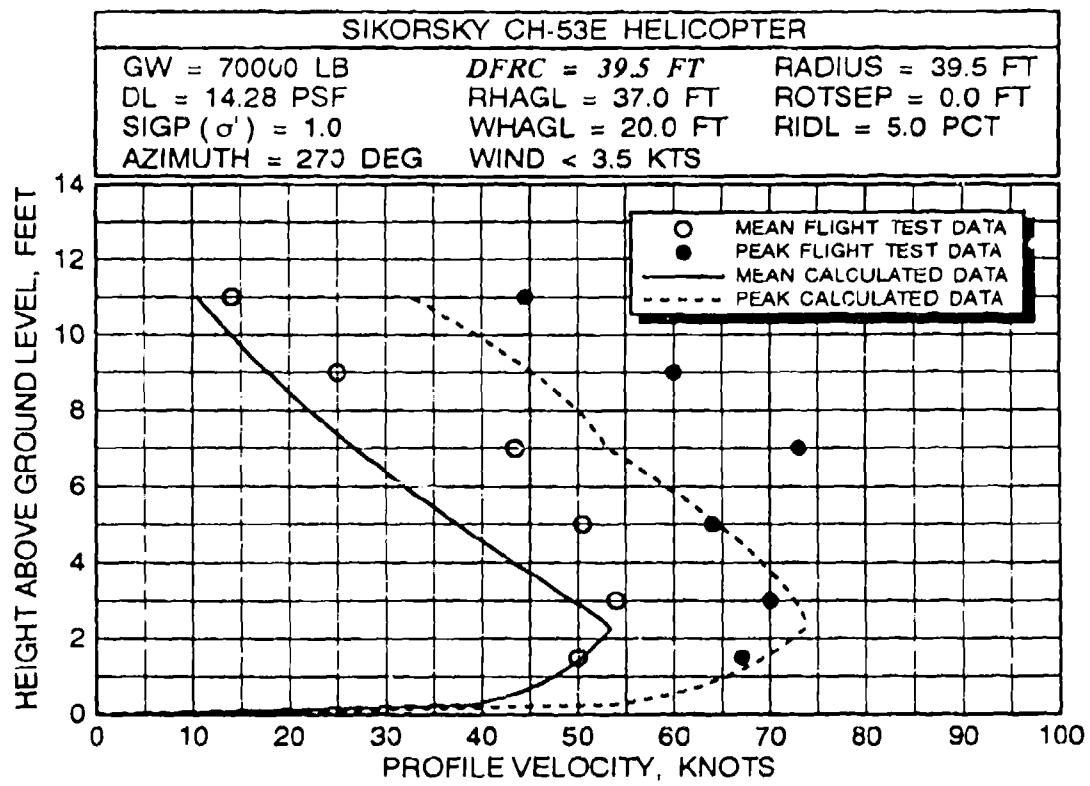
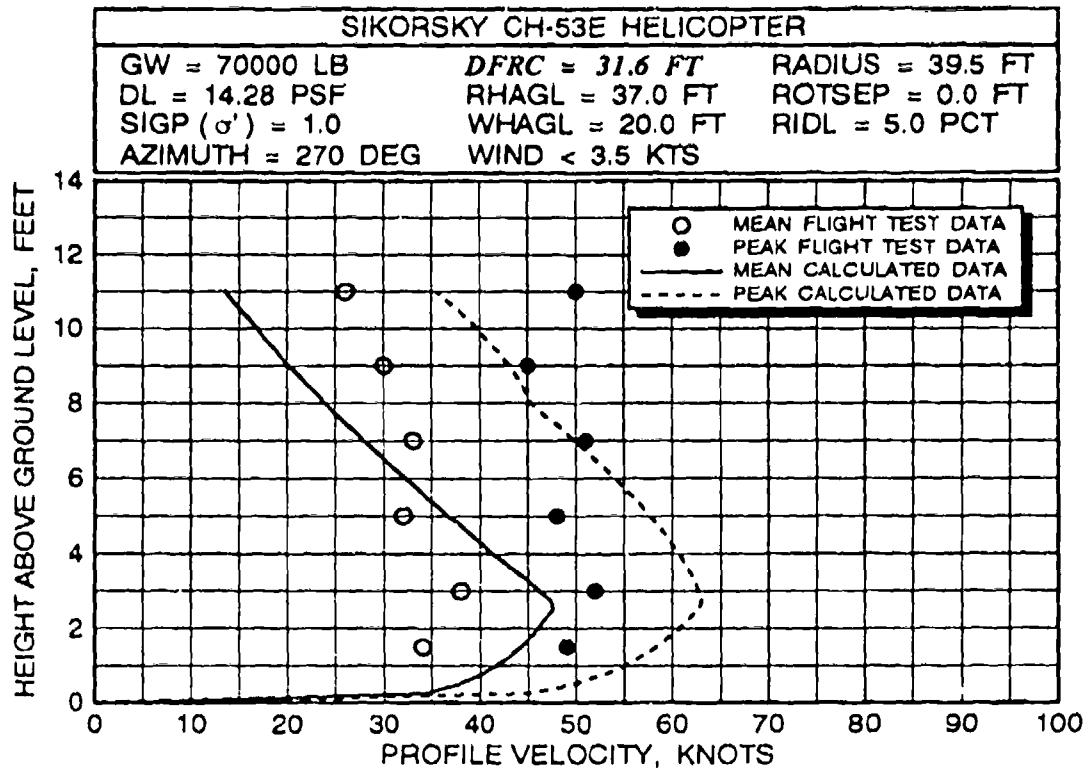


FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS

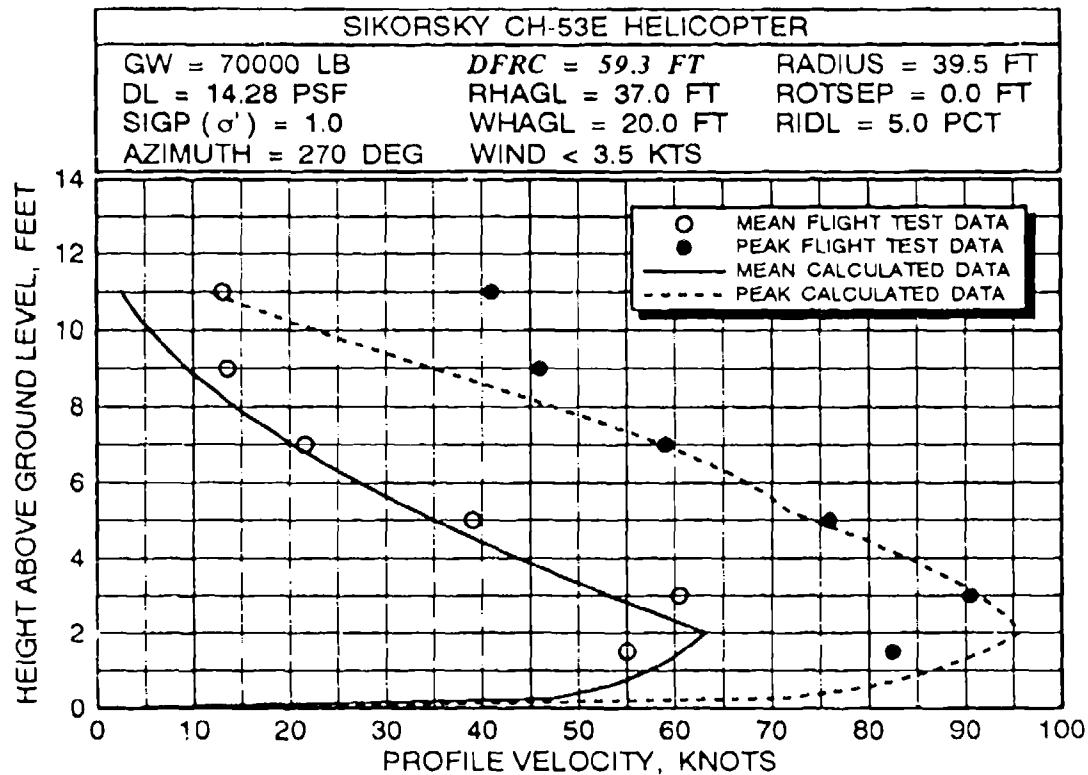
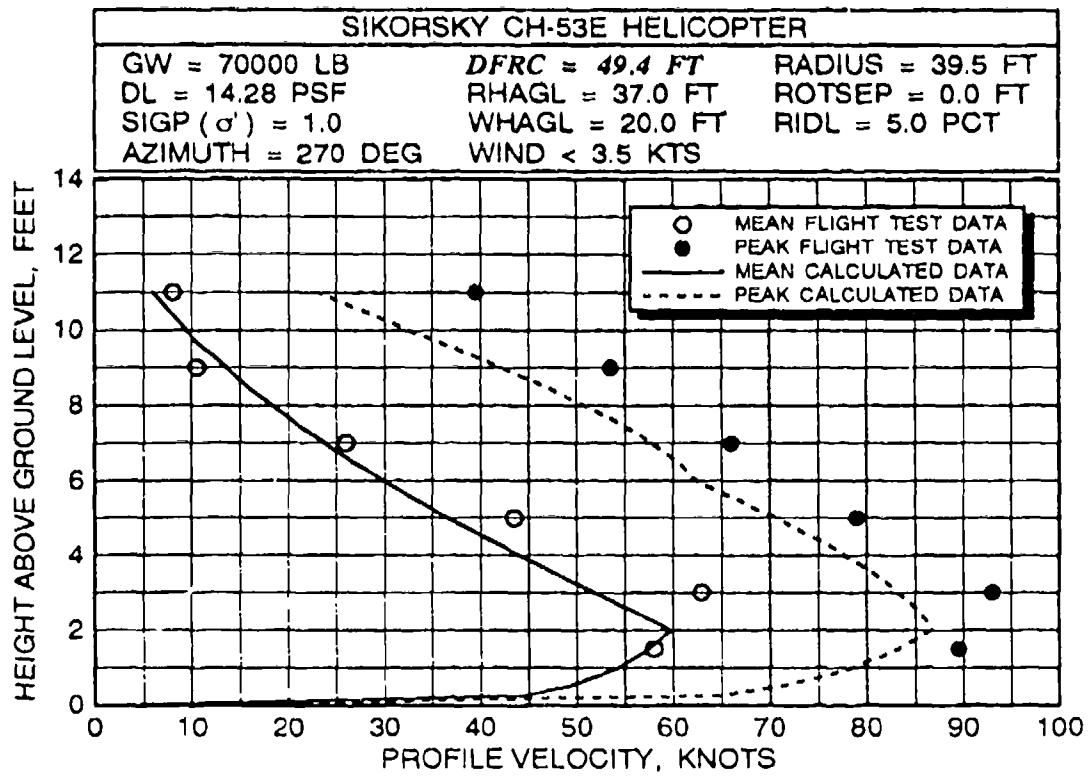
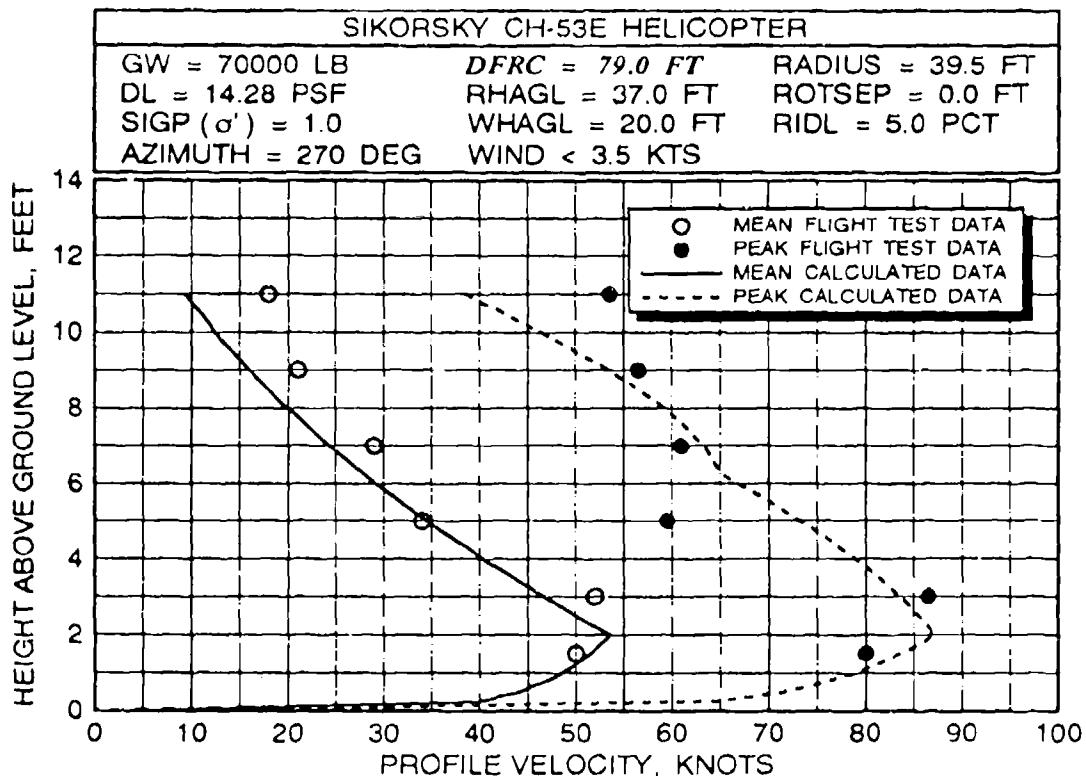
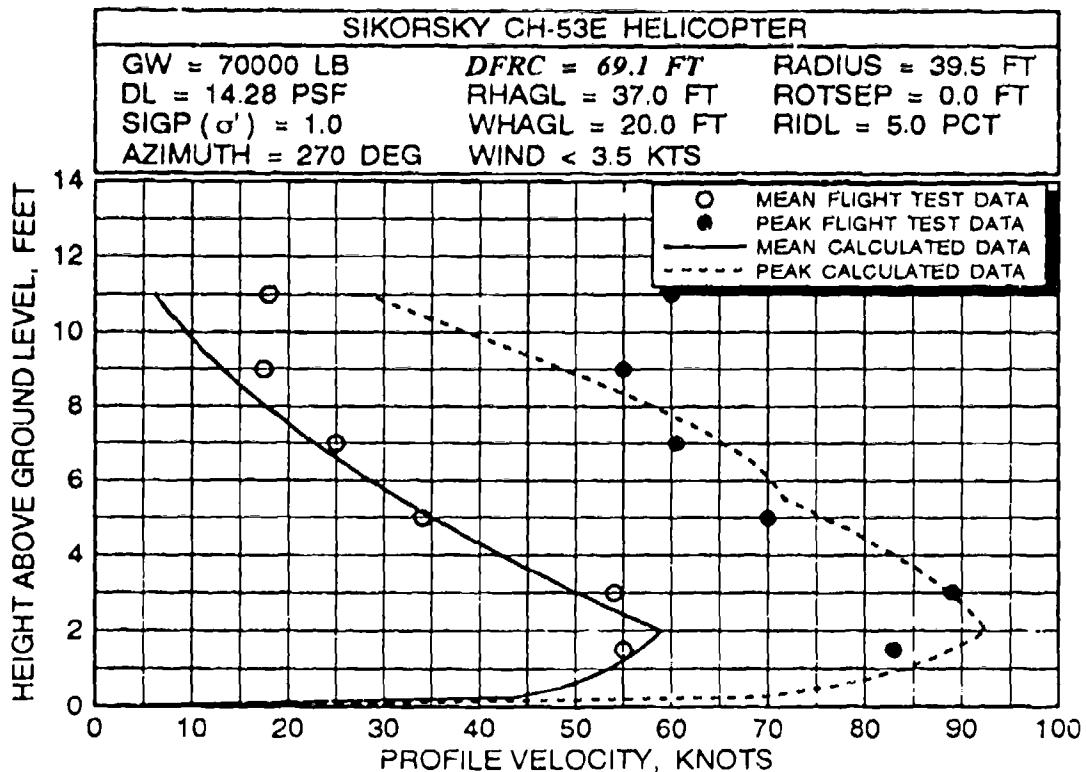
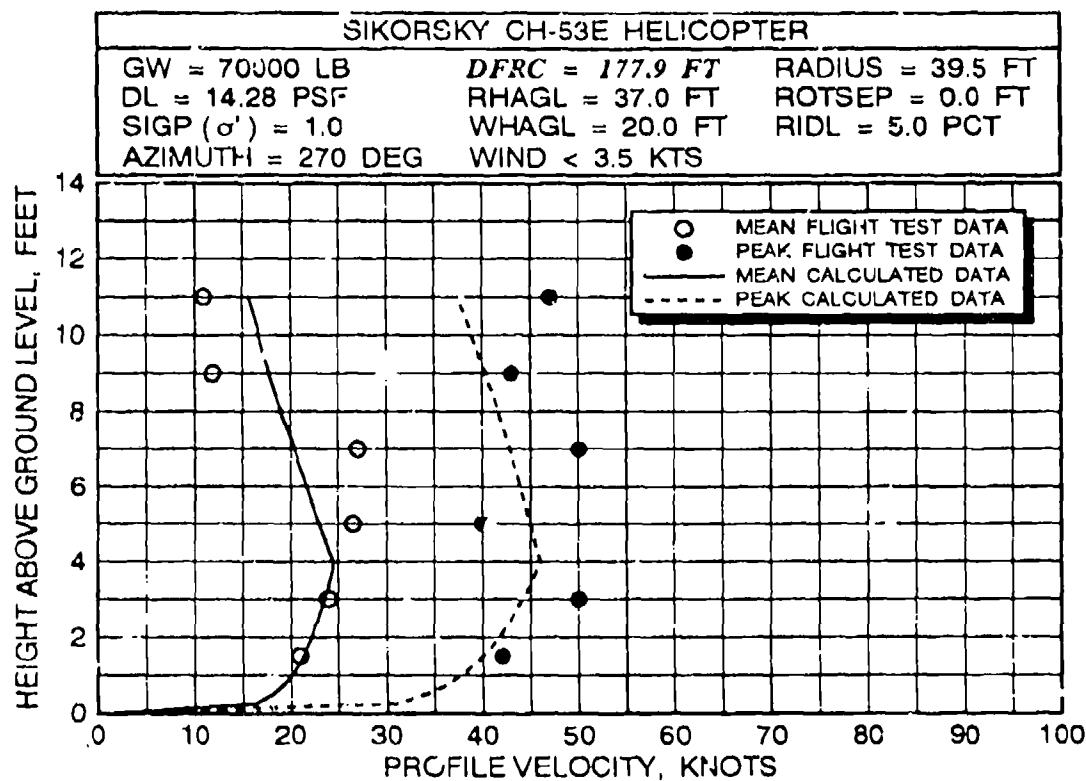
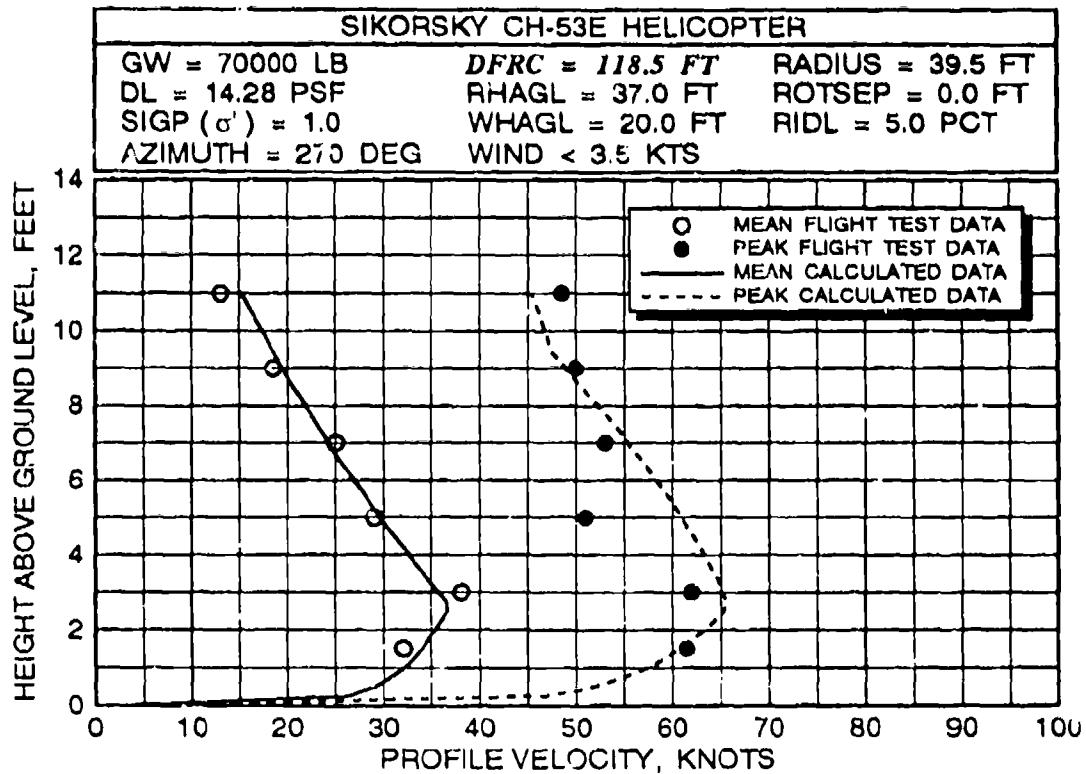


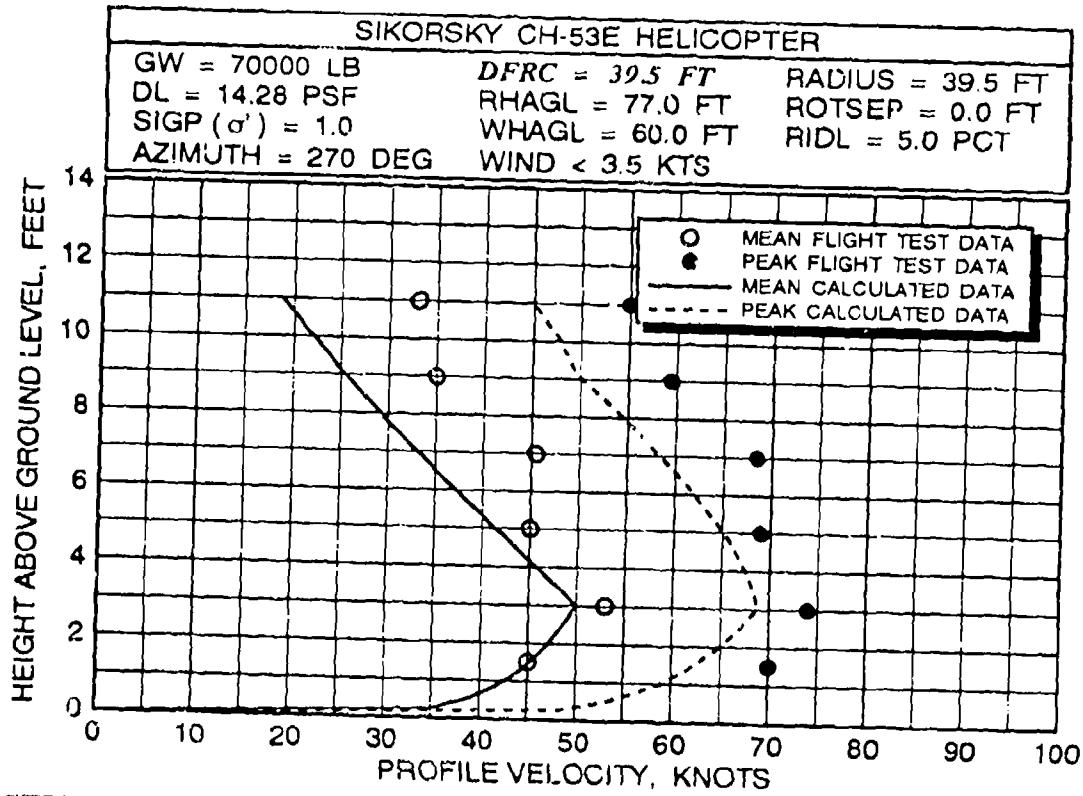
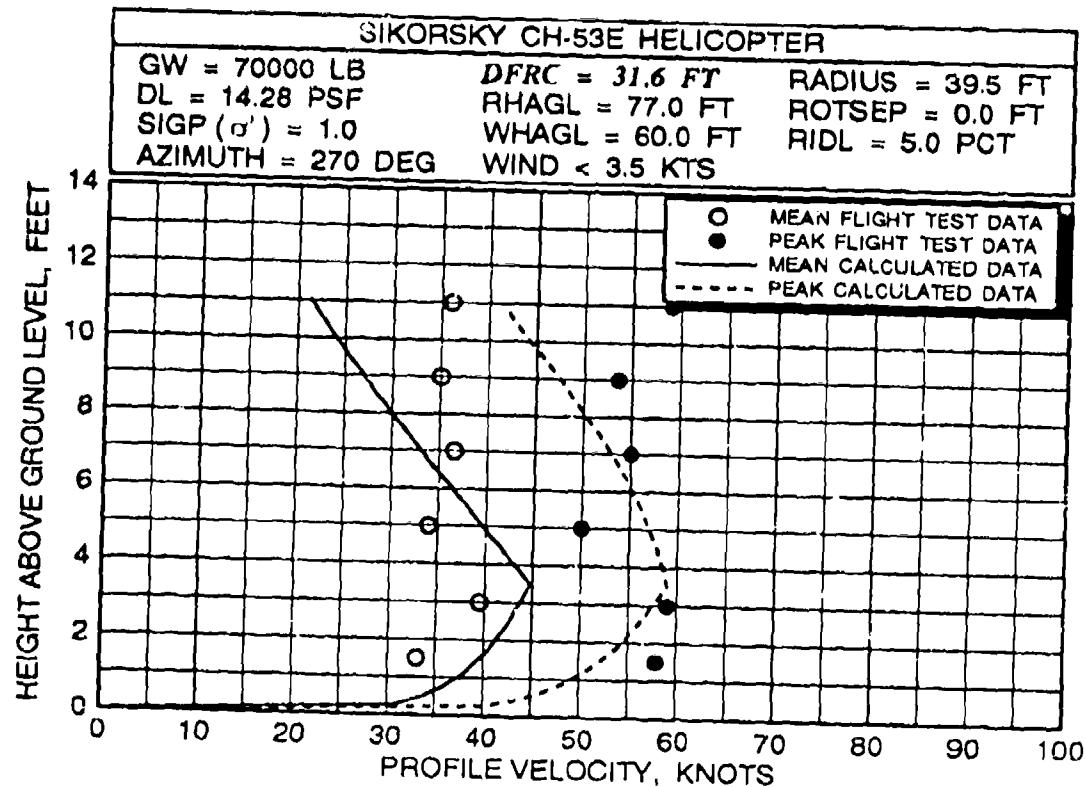
FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)



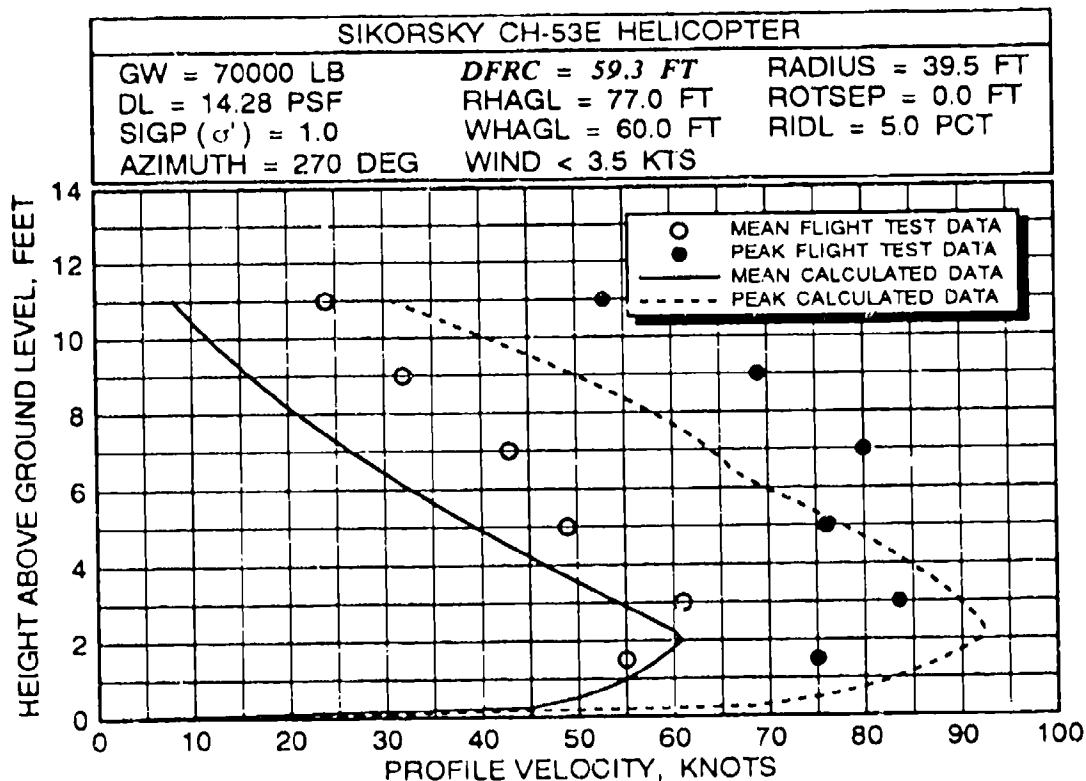
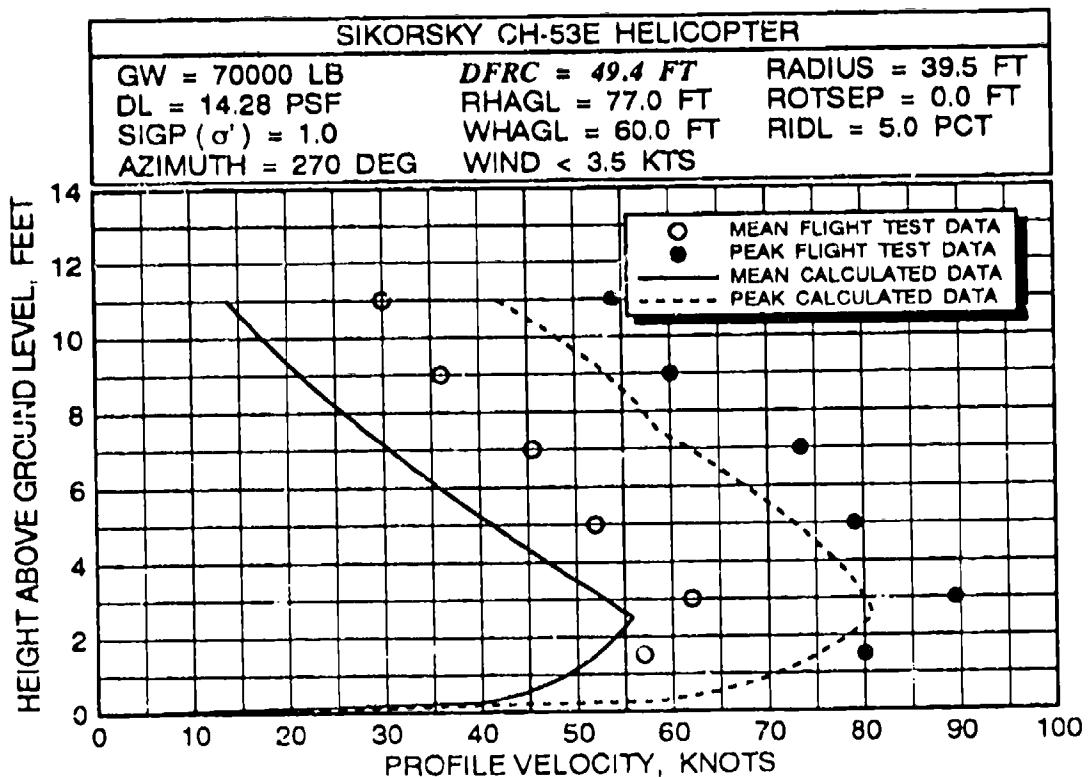
**FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**



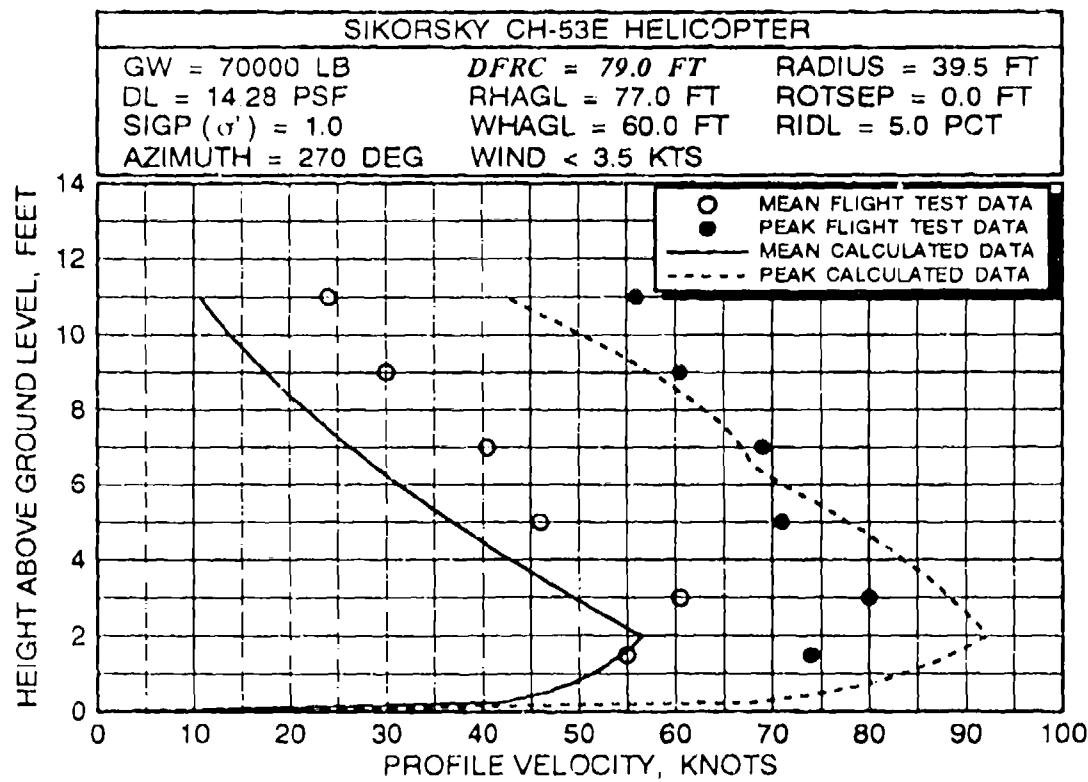
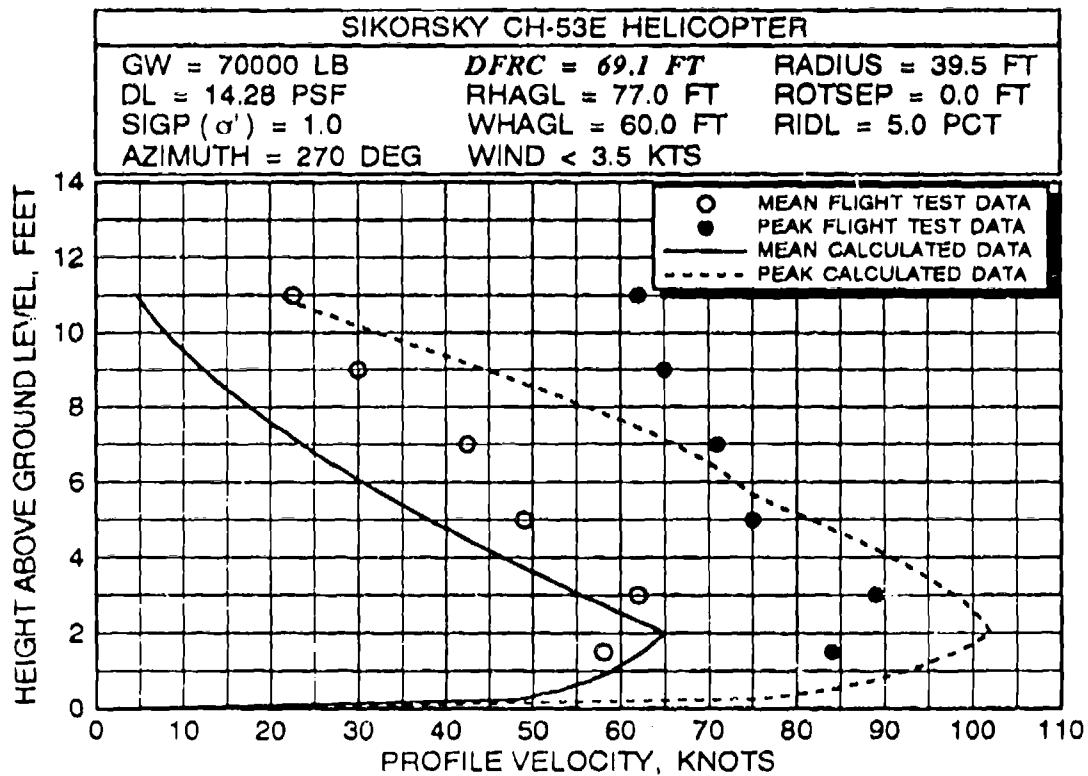
**FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**



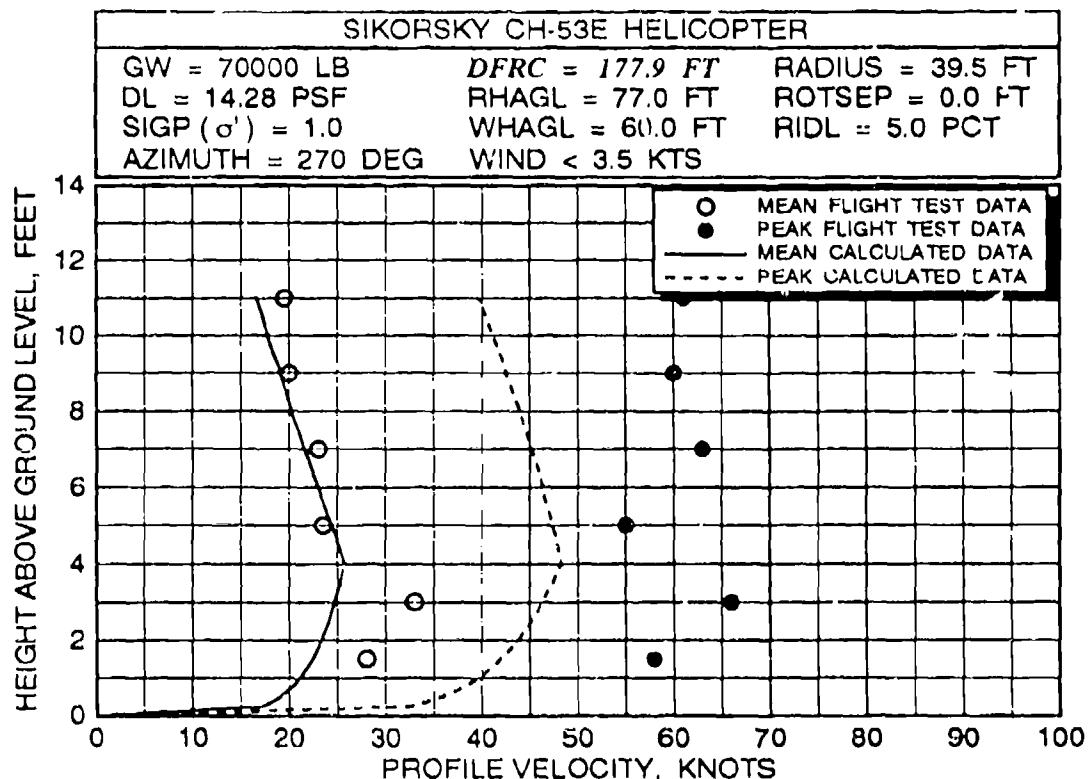
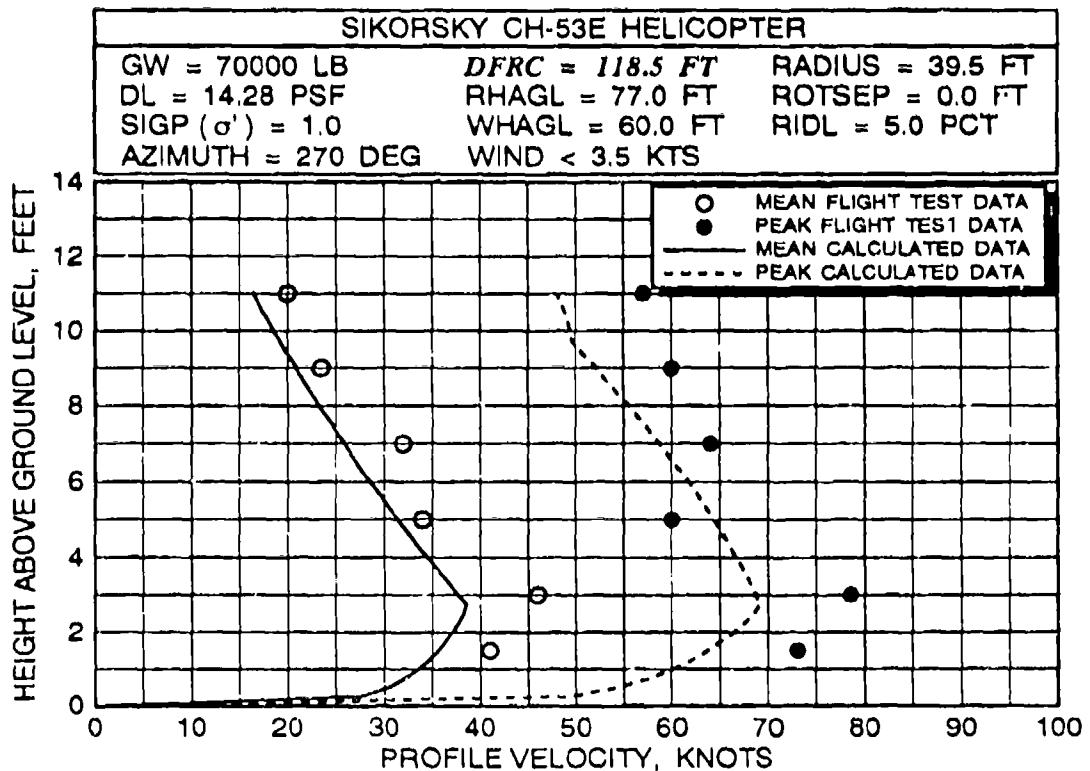
**FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS**



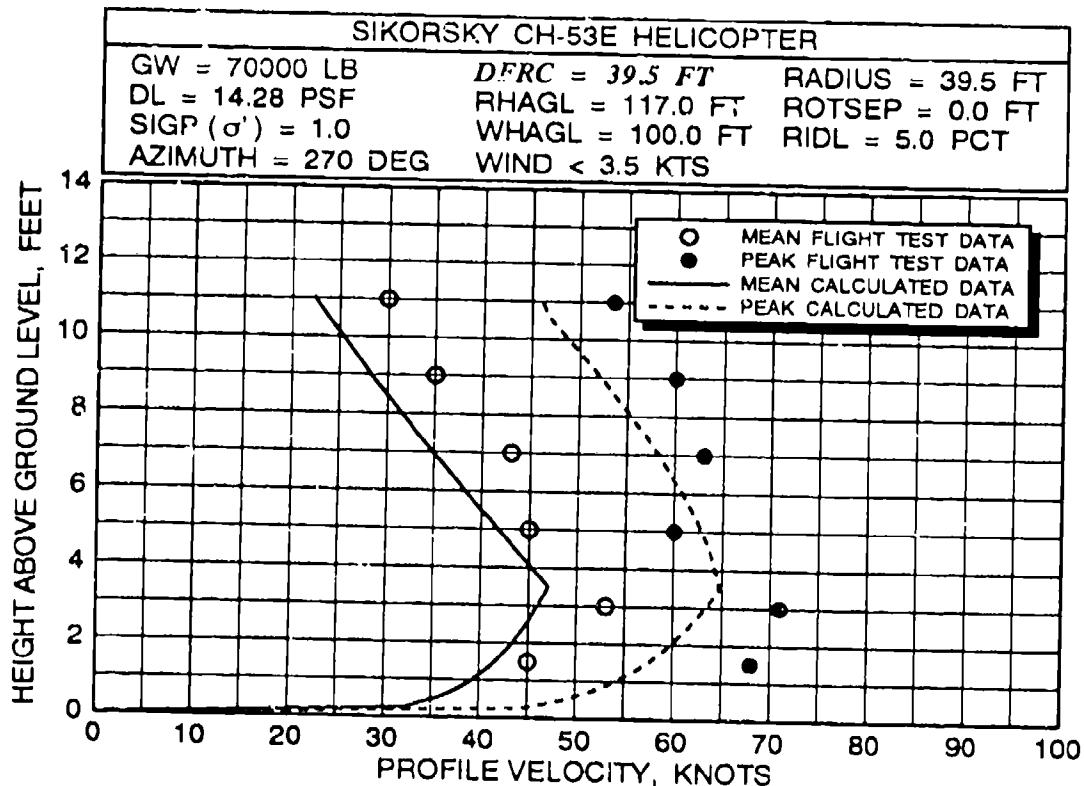
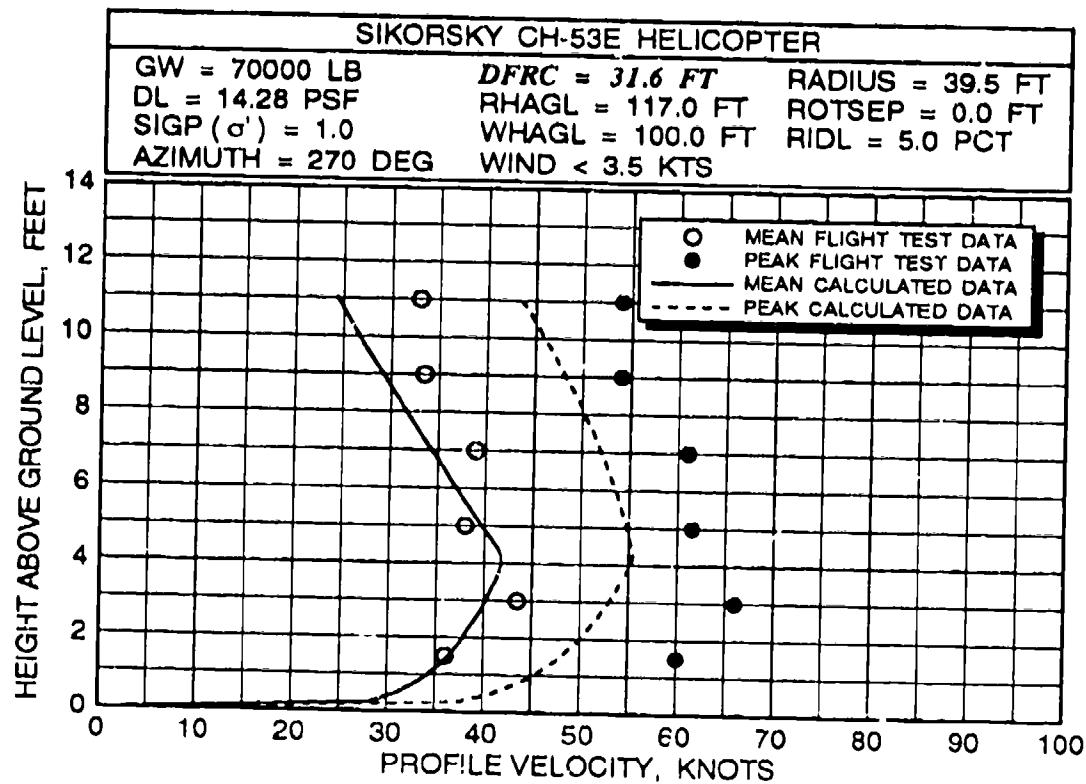
**FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**



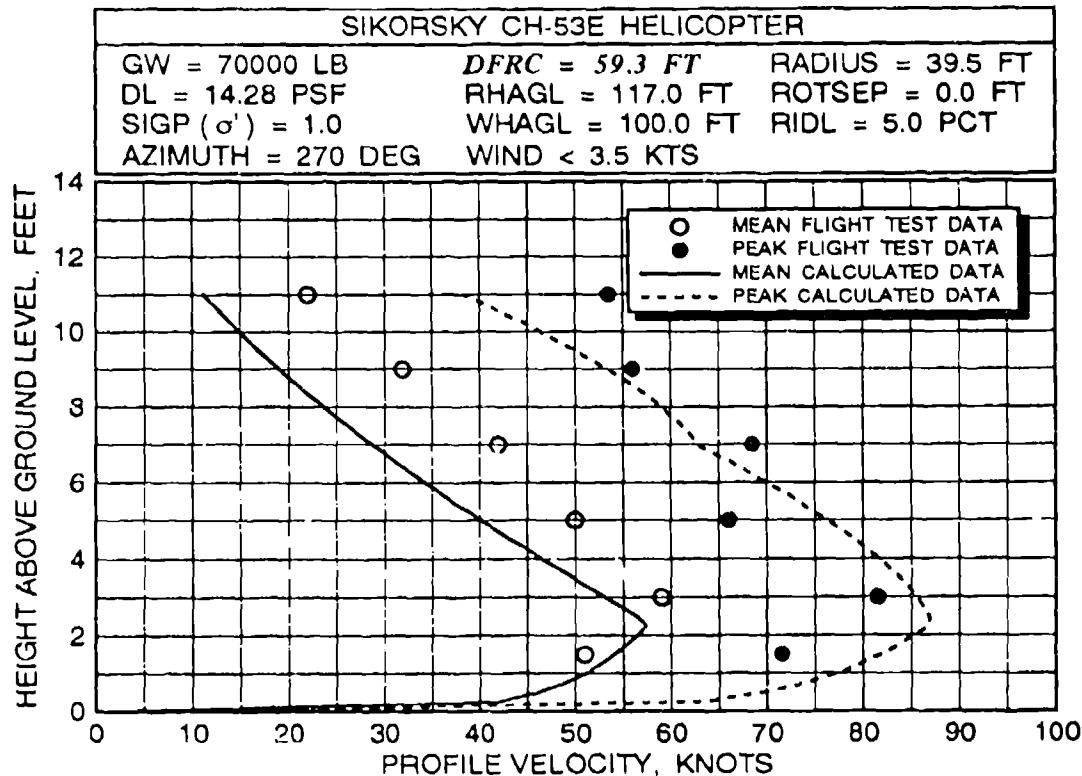
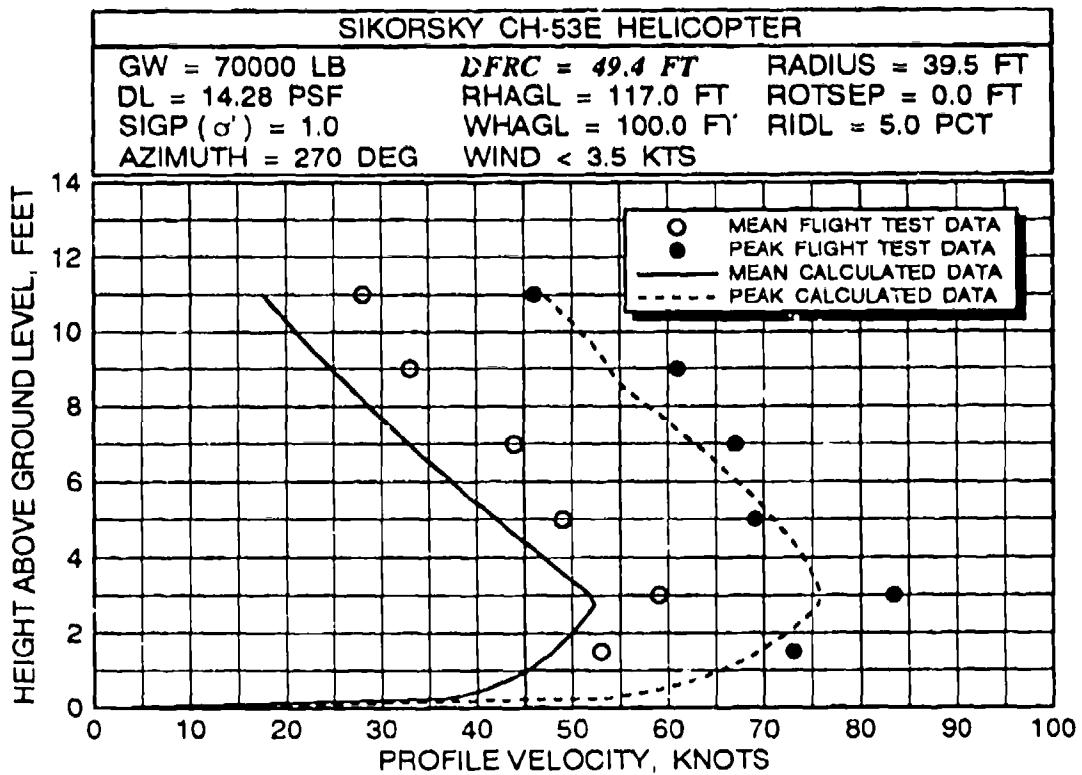
**FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**



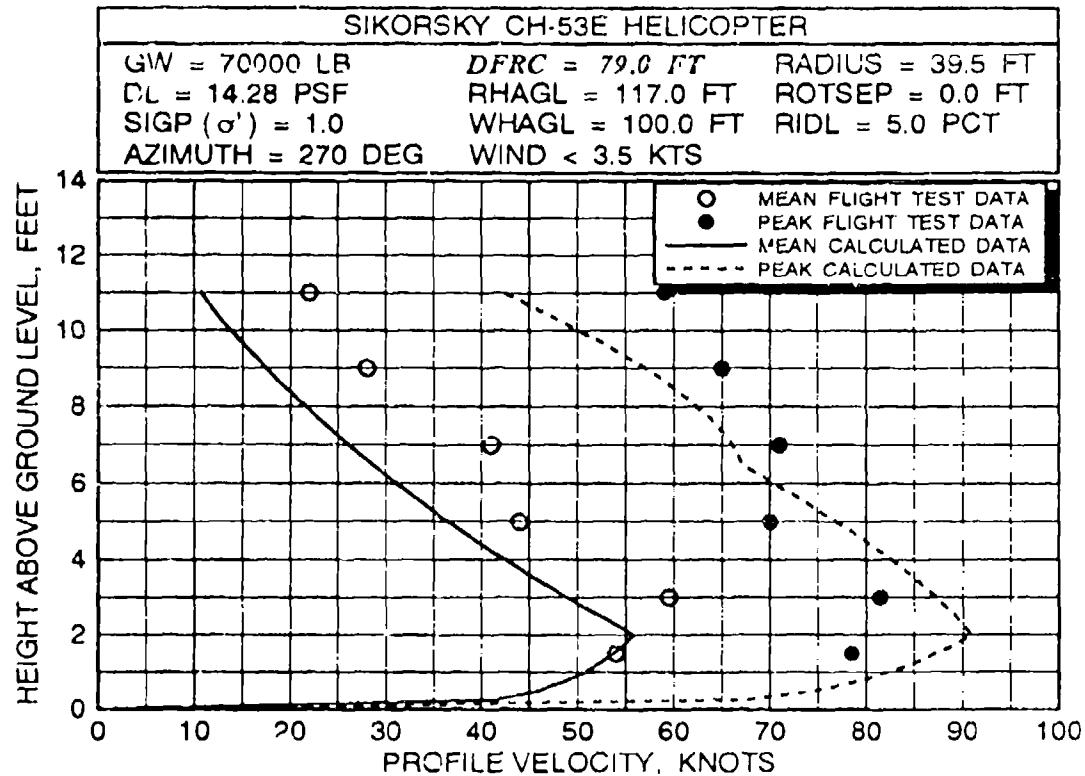
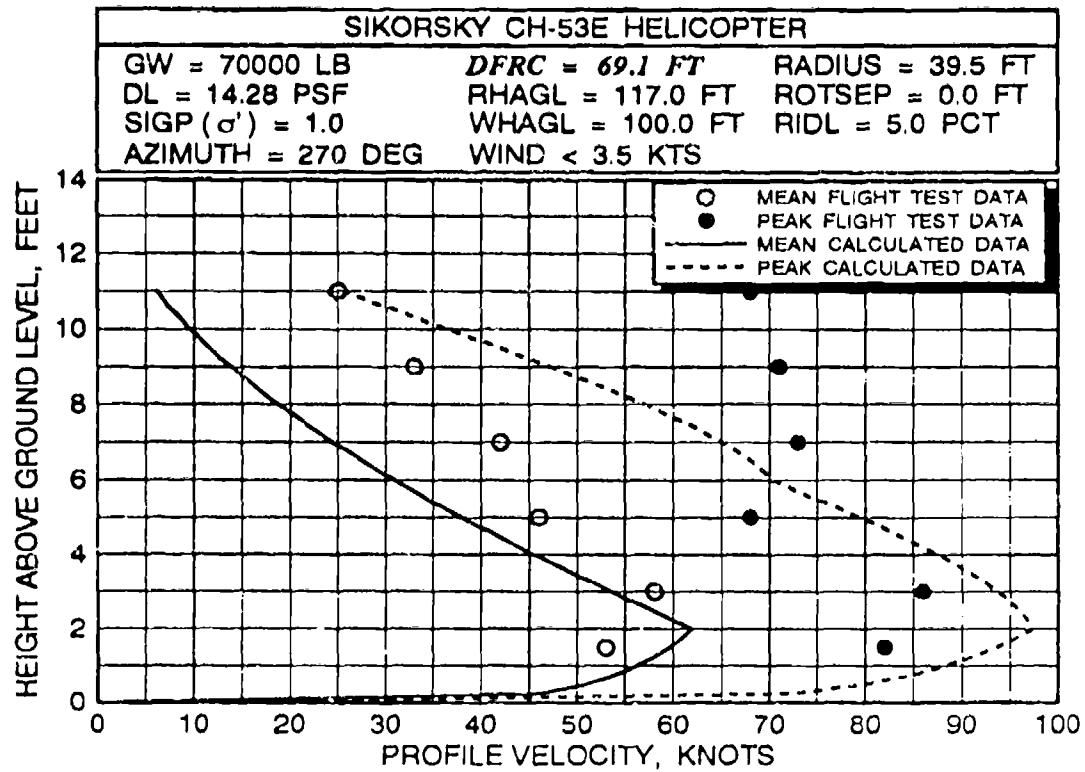
**FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**



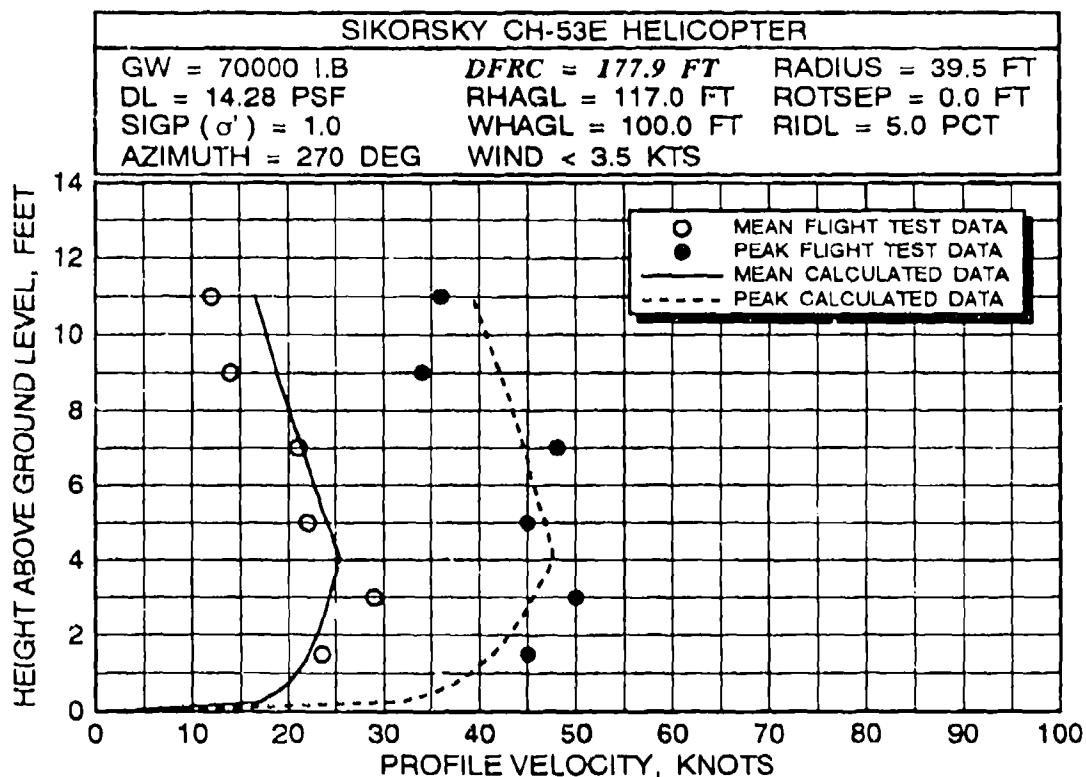
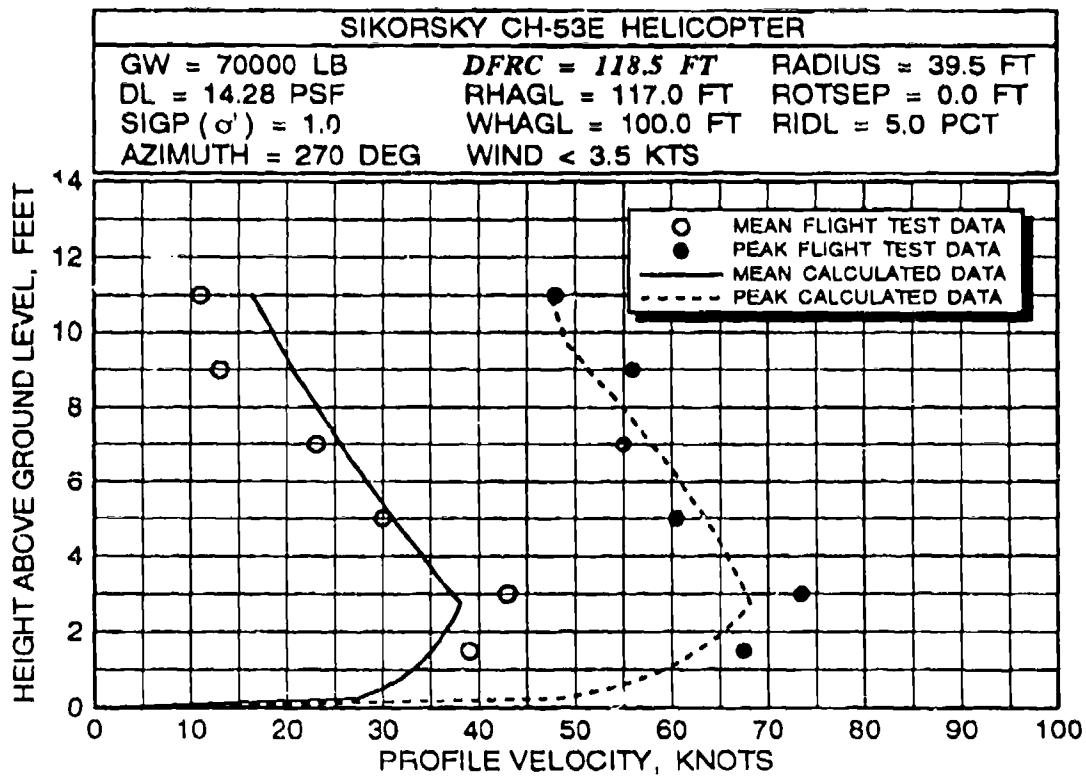
**FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS**



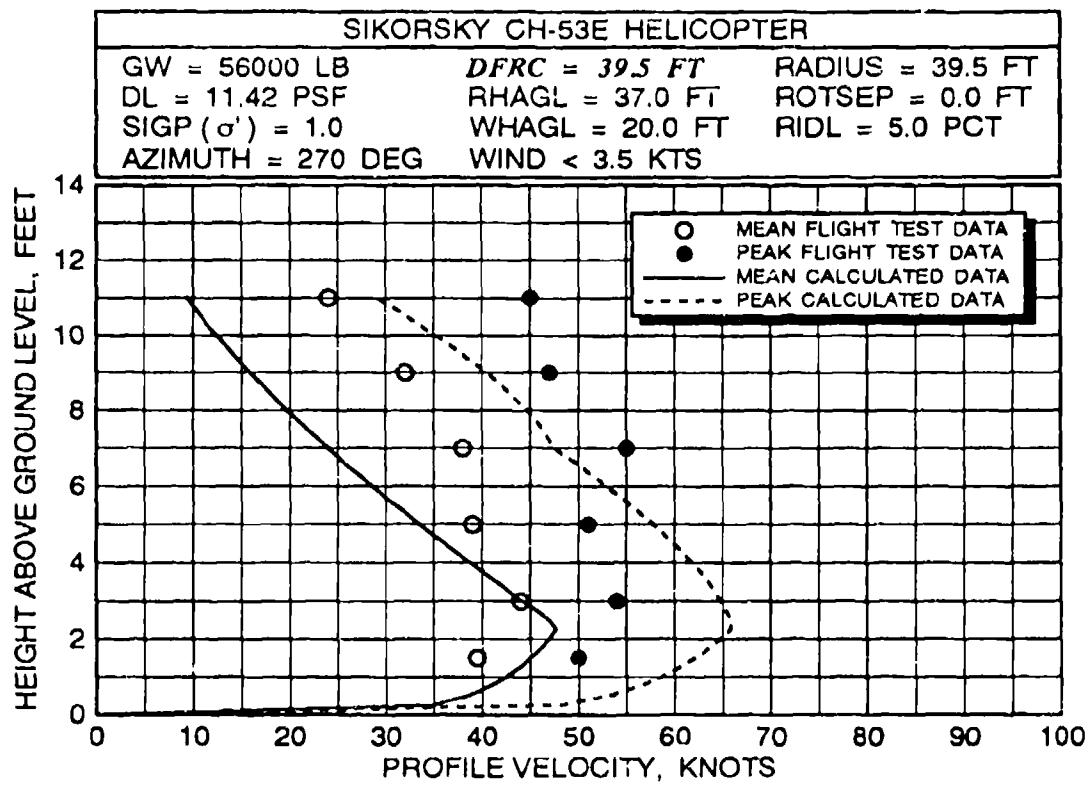
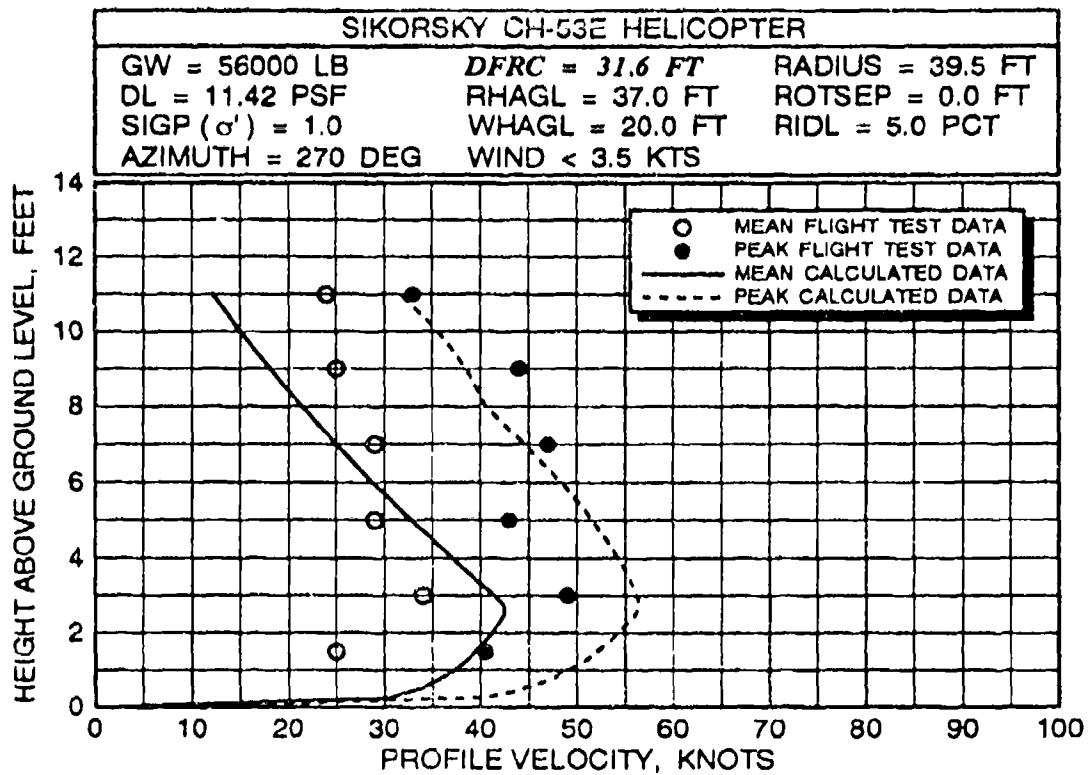
**FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**



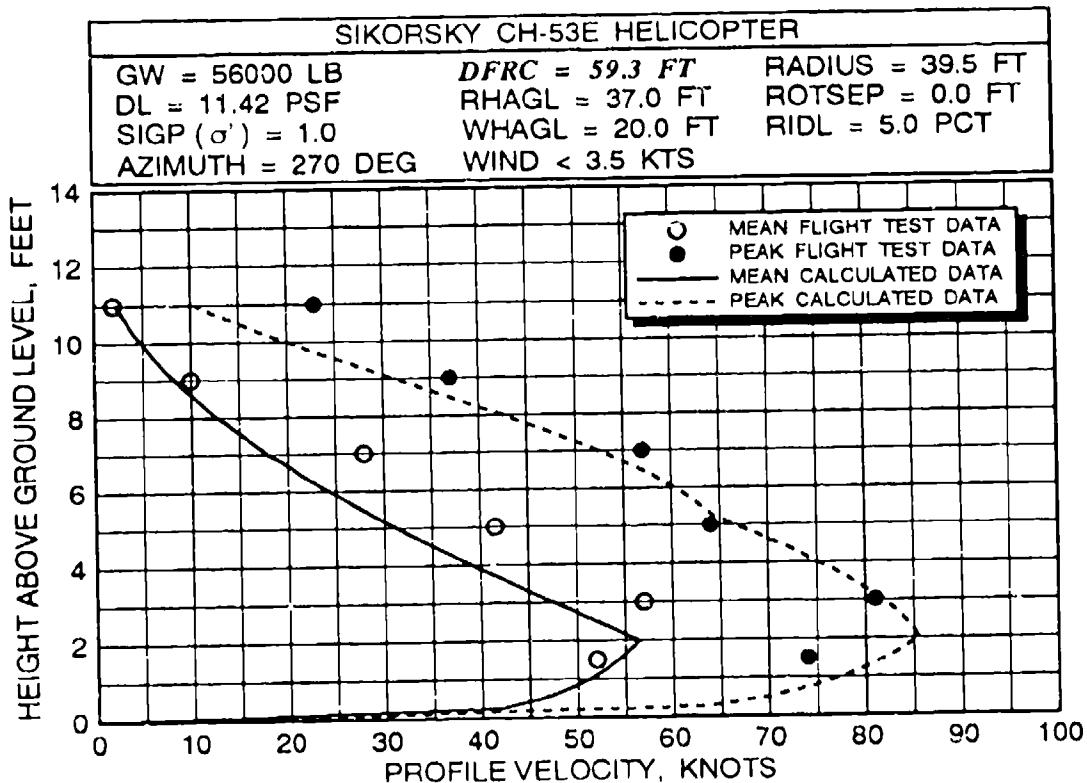
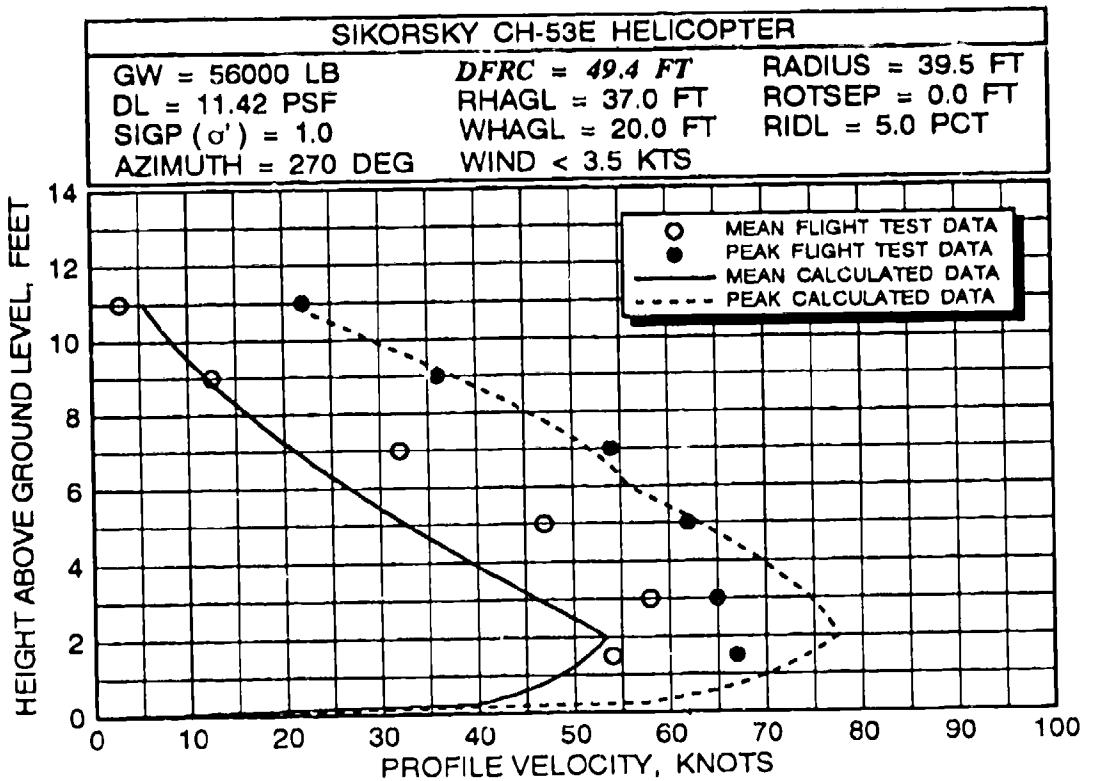
**FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**



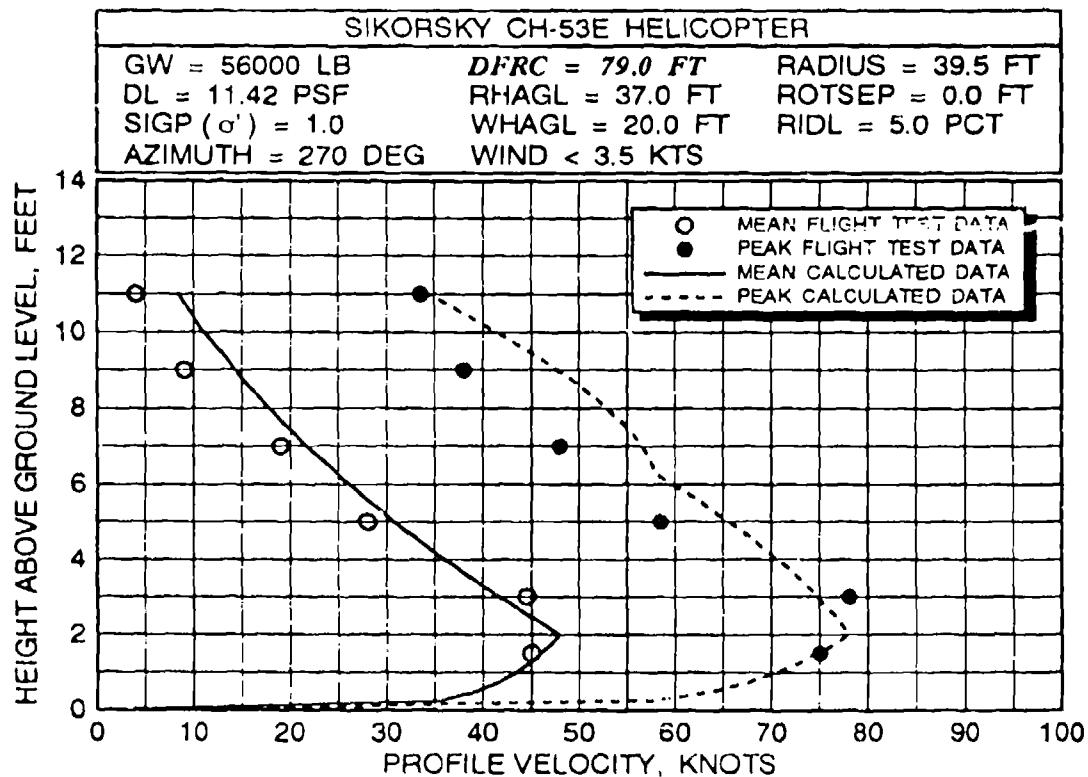
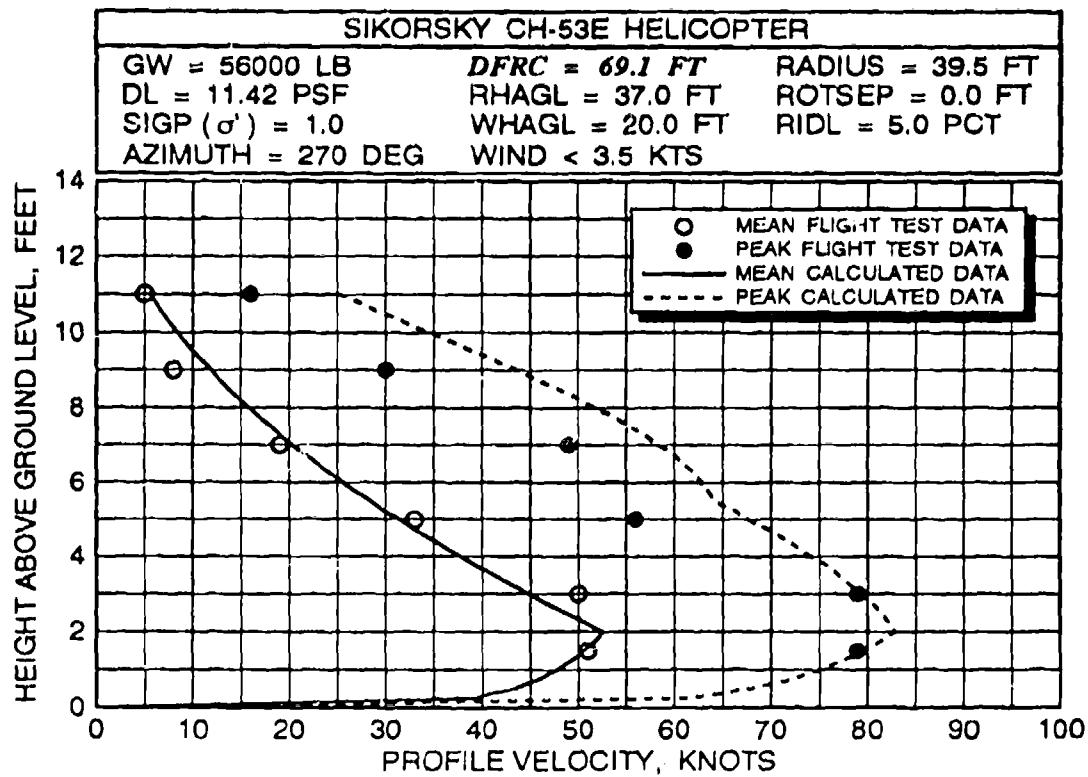
**FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**



**FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS**



**FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**



**FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**

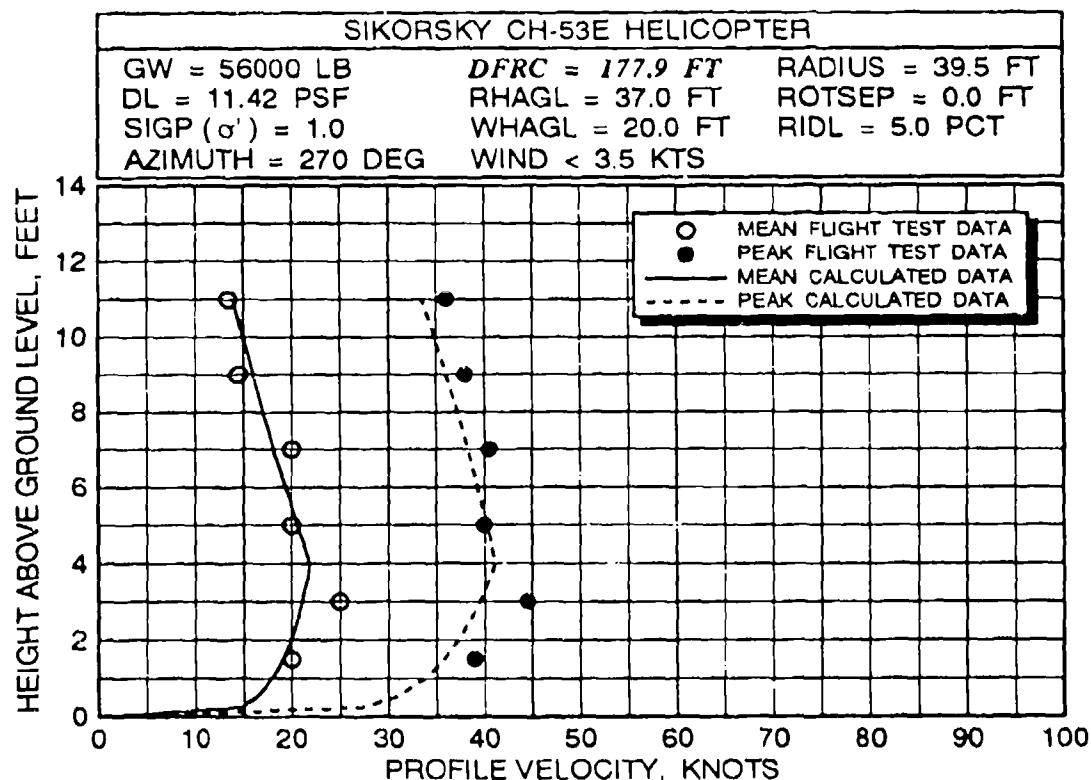
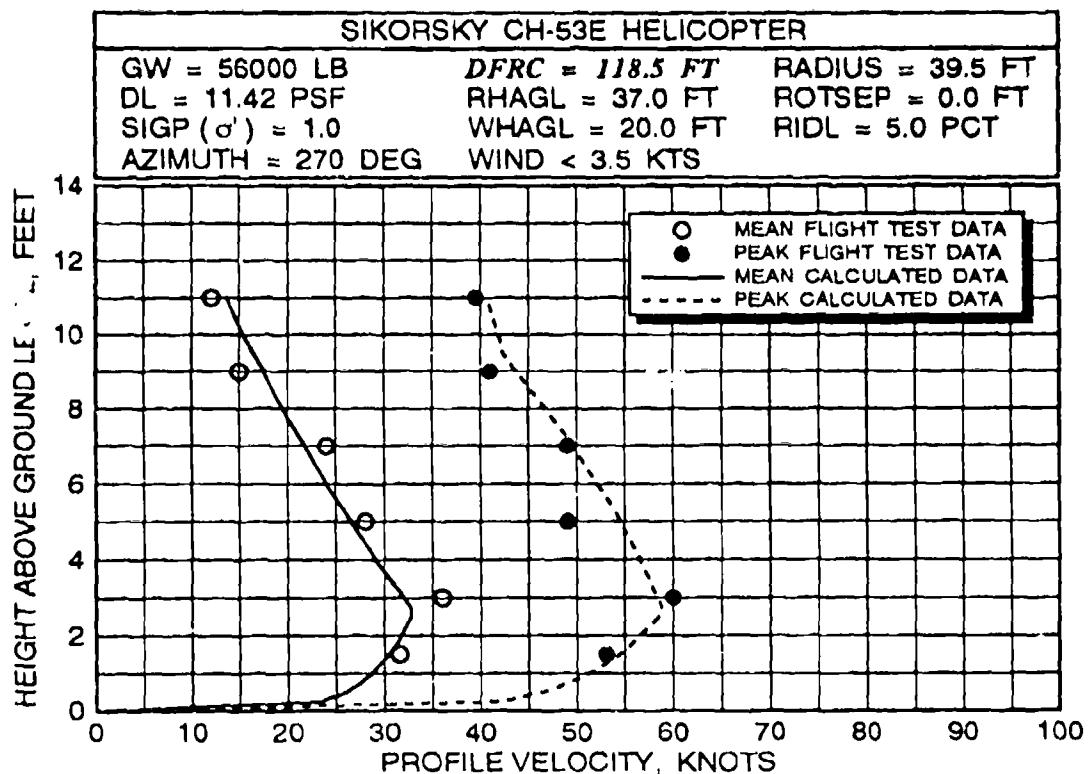
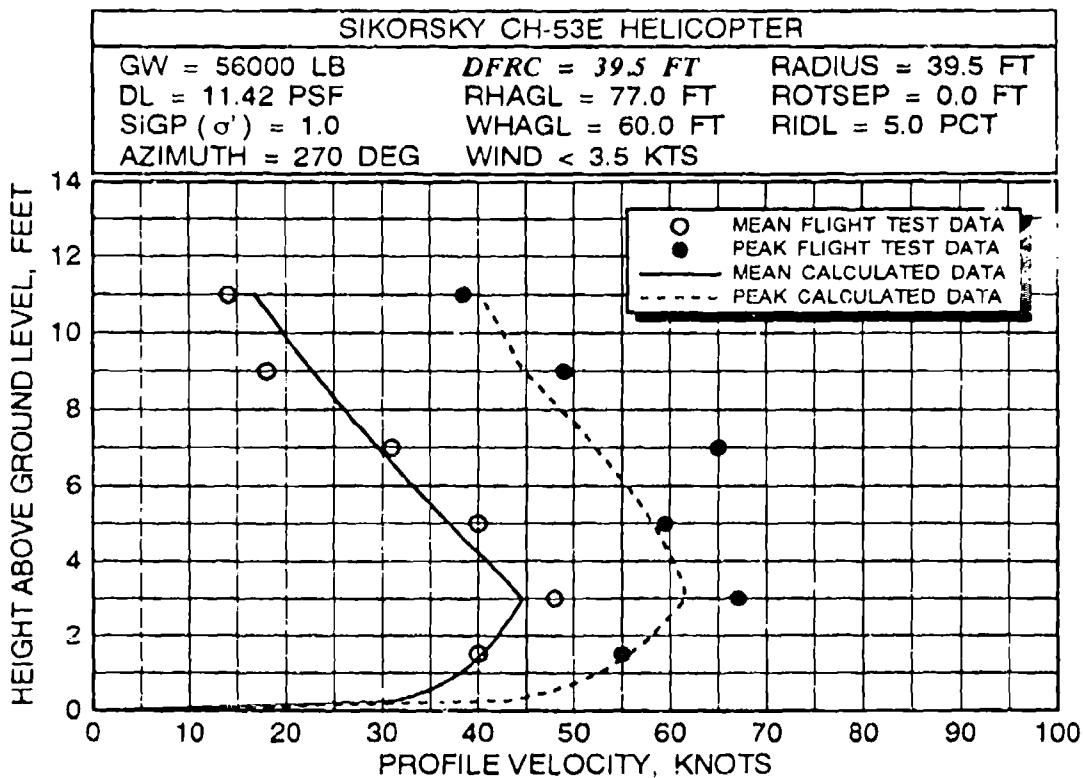
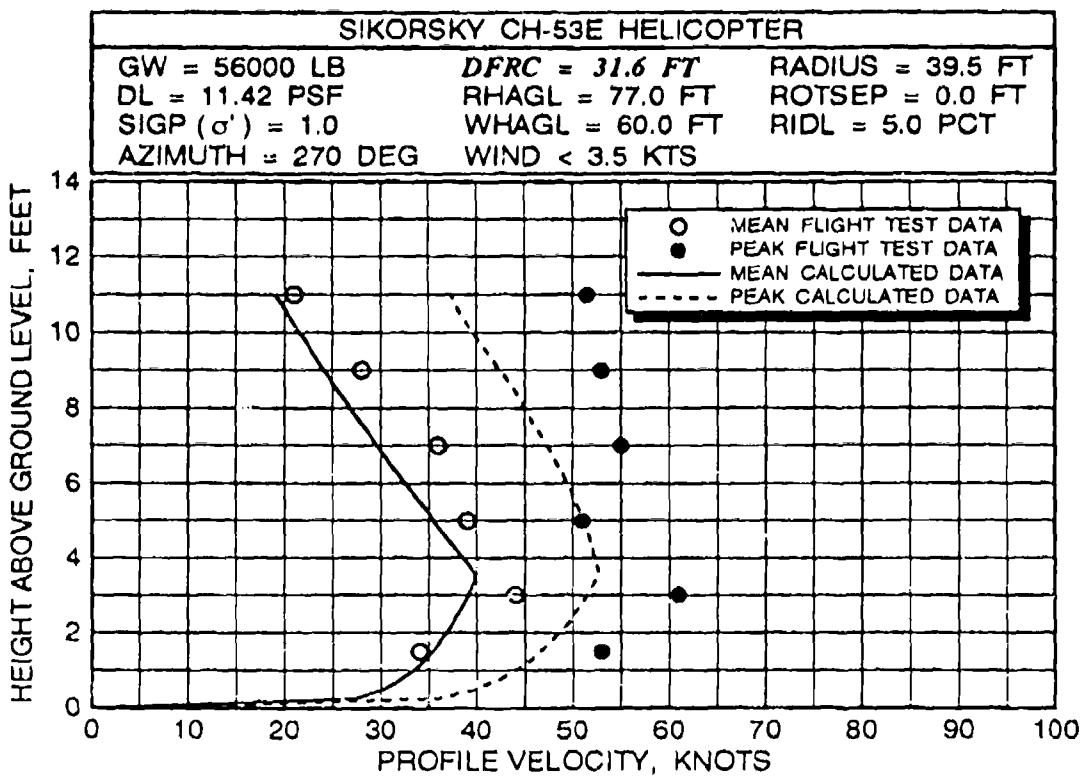
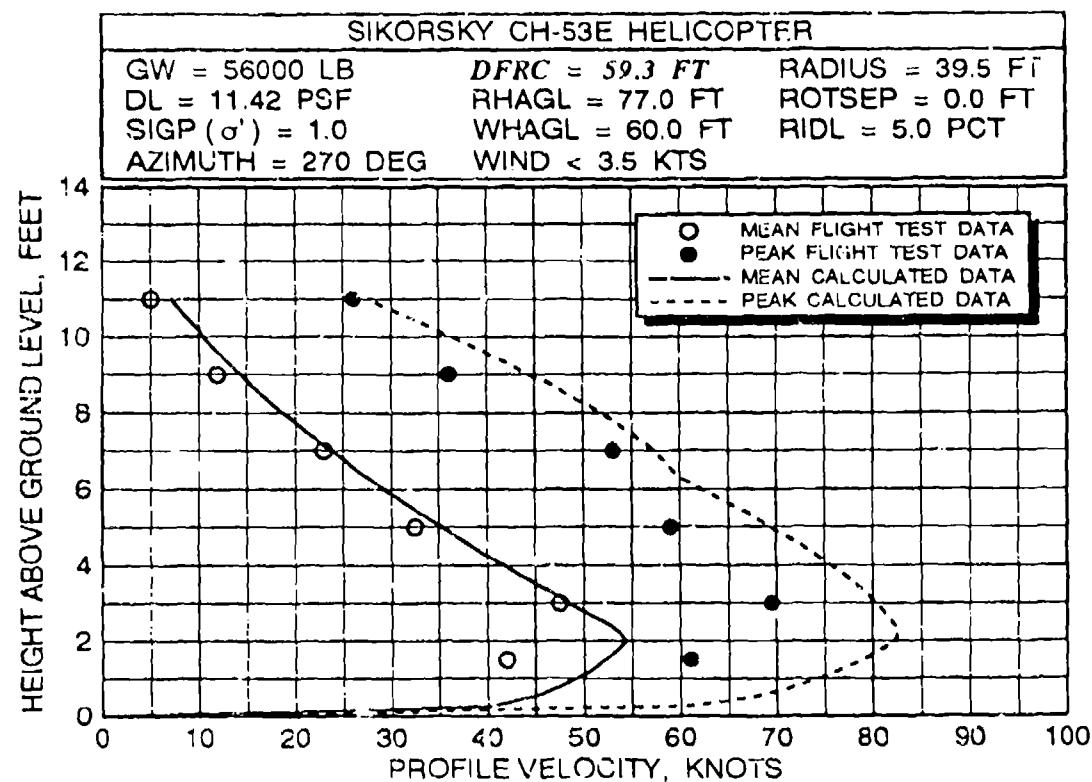
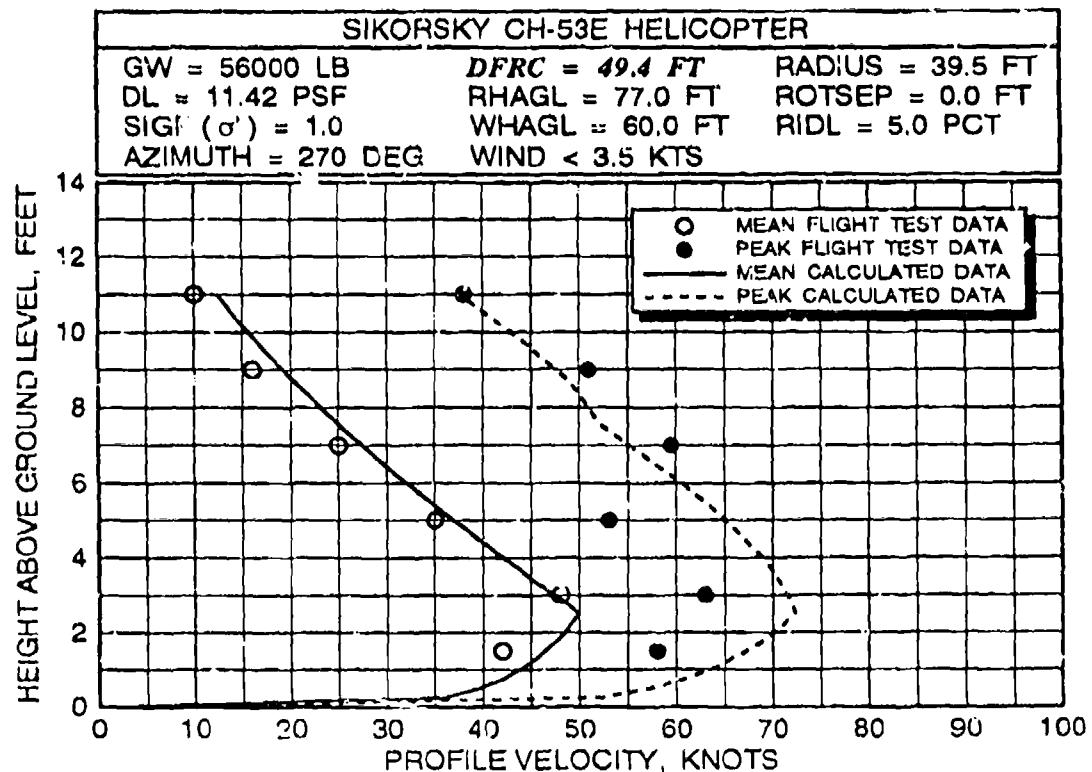


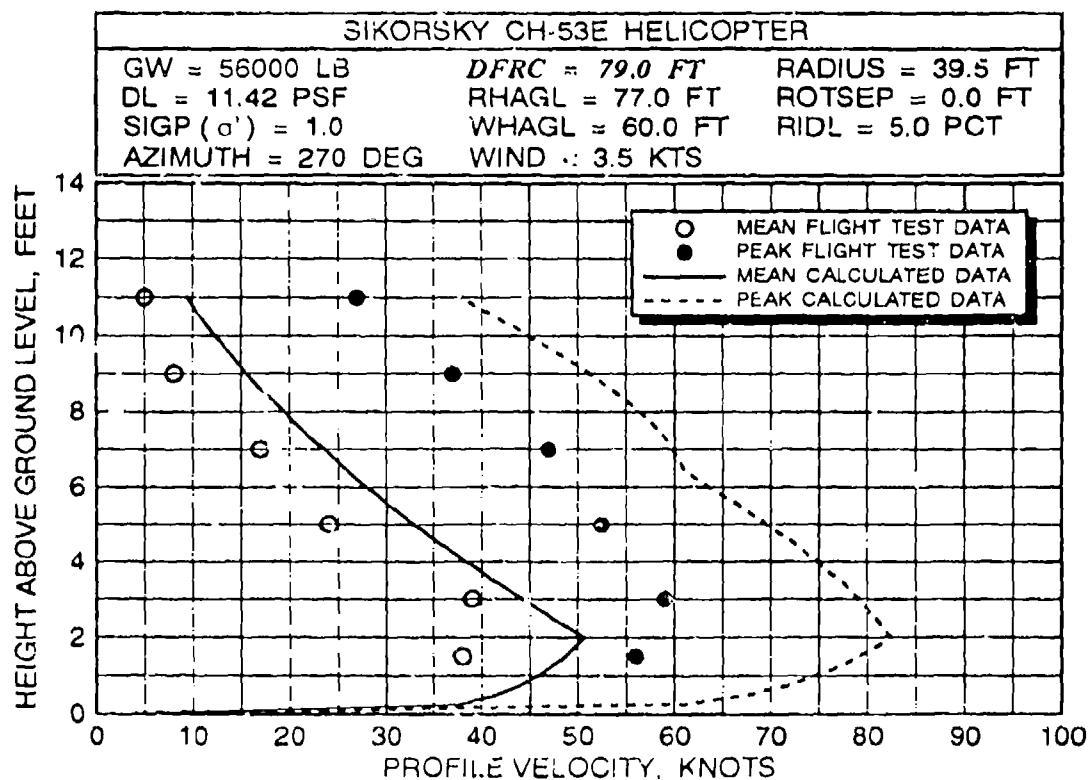
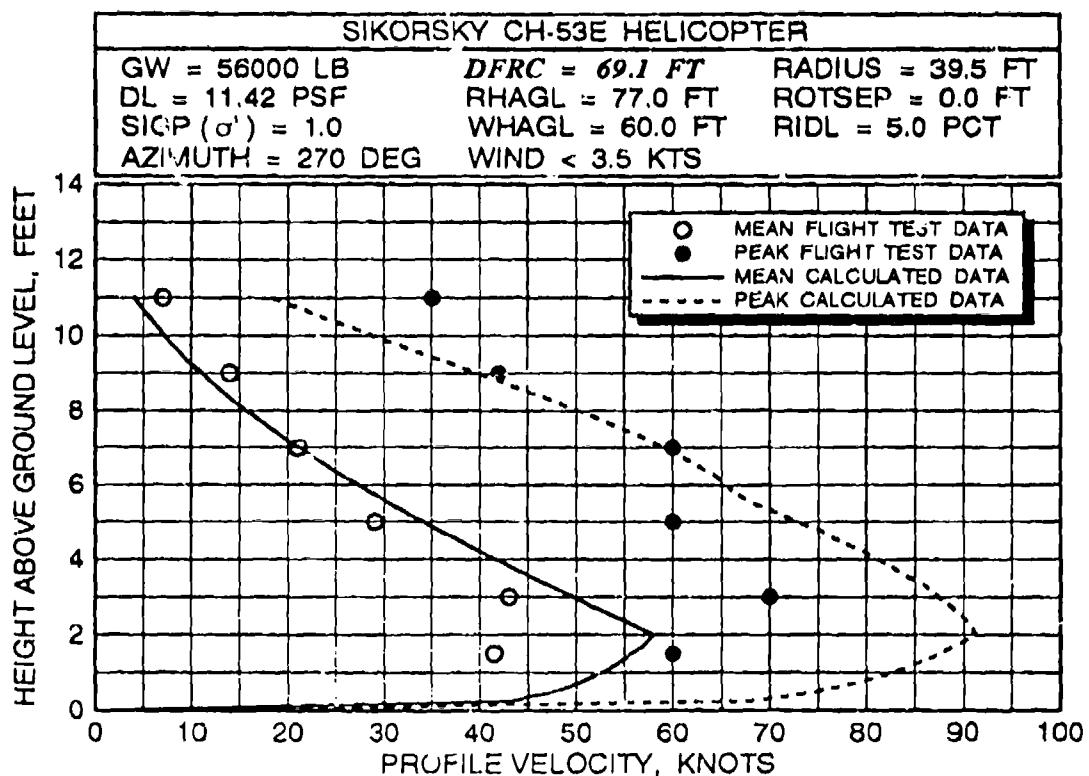
FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)



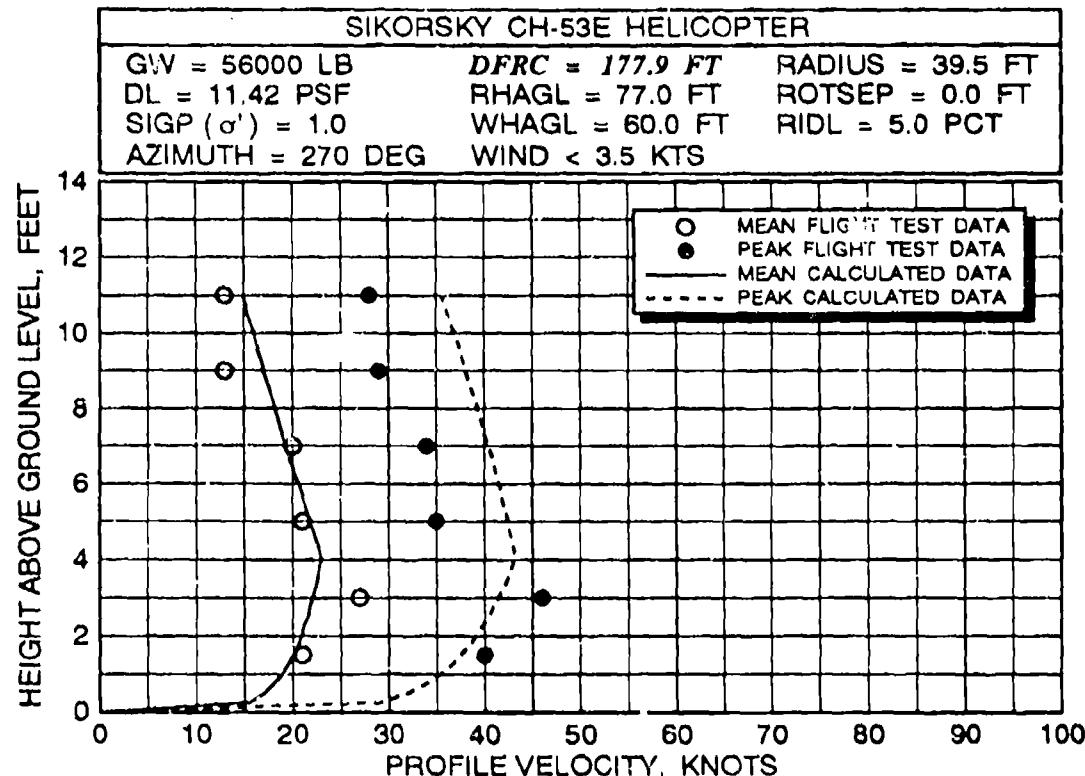
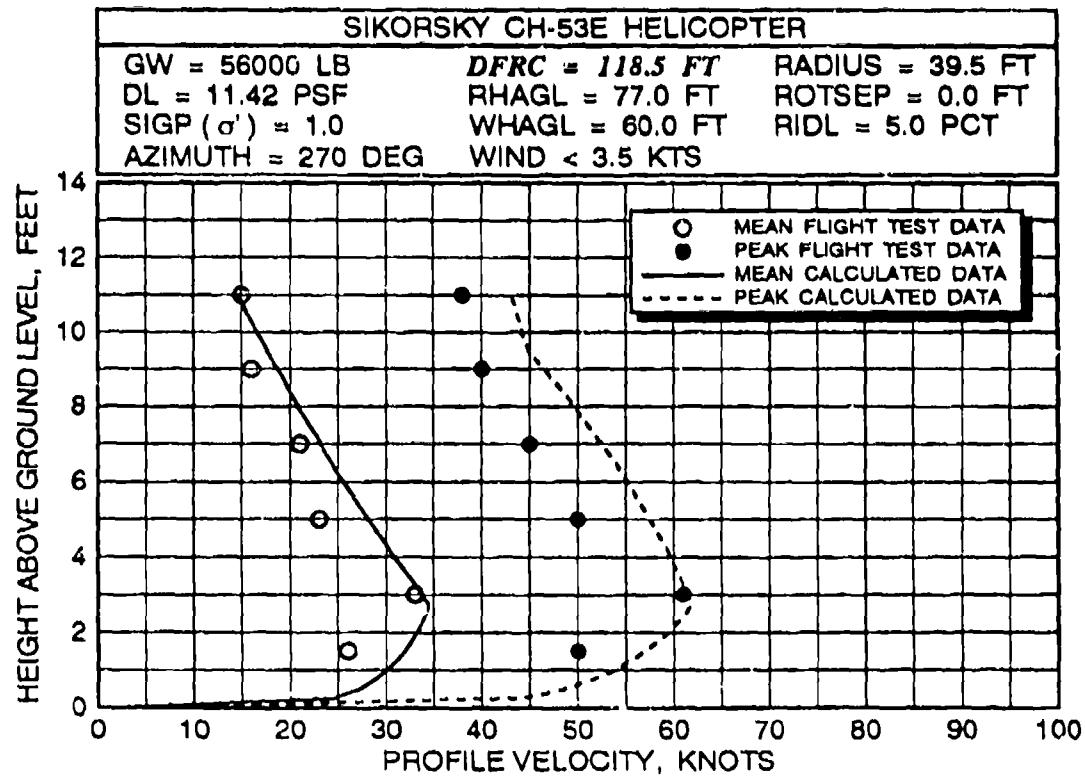
**FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**



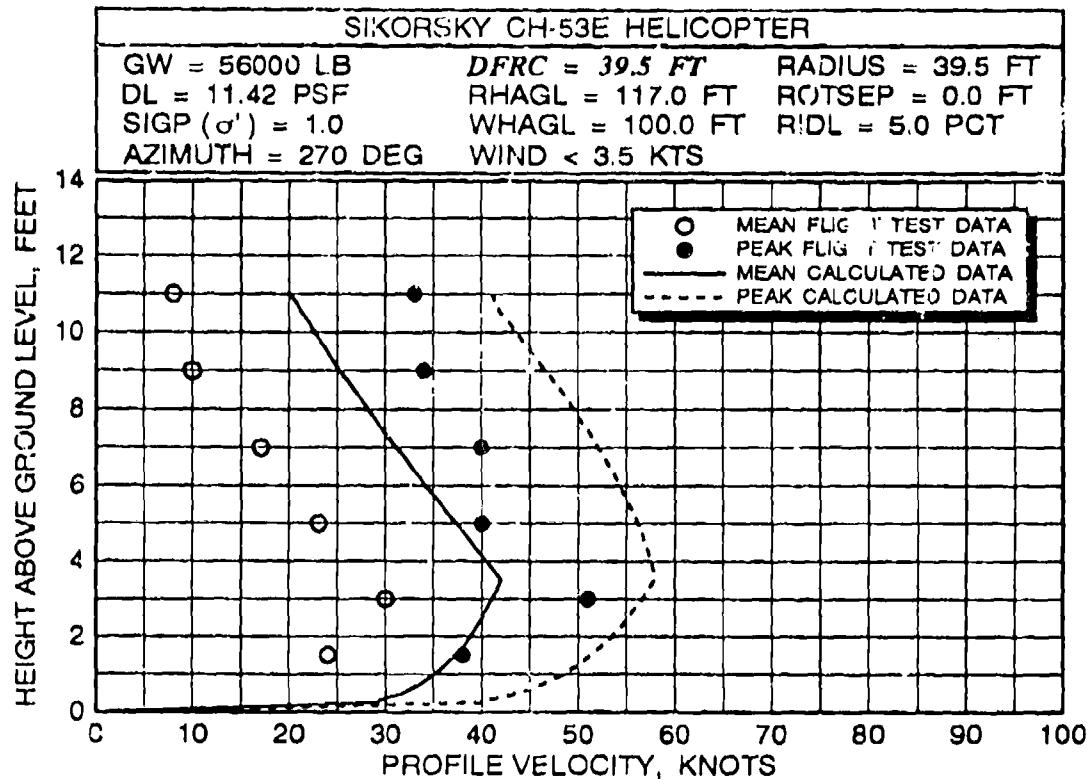
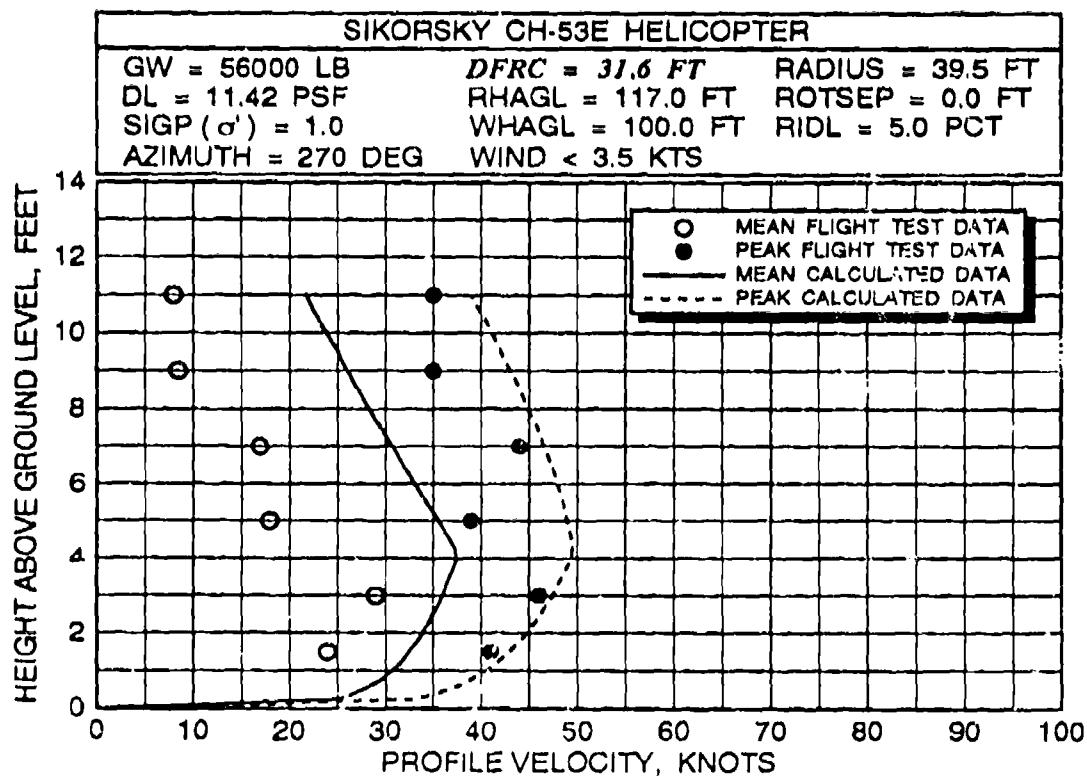
**FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**



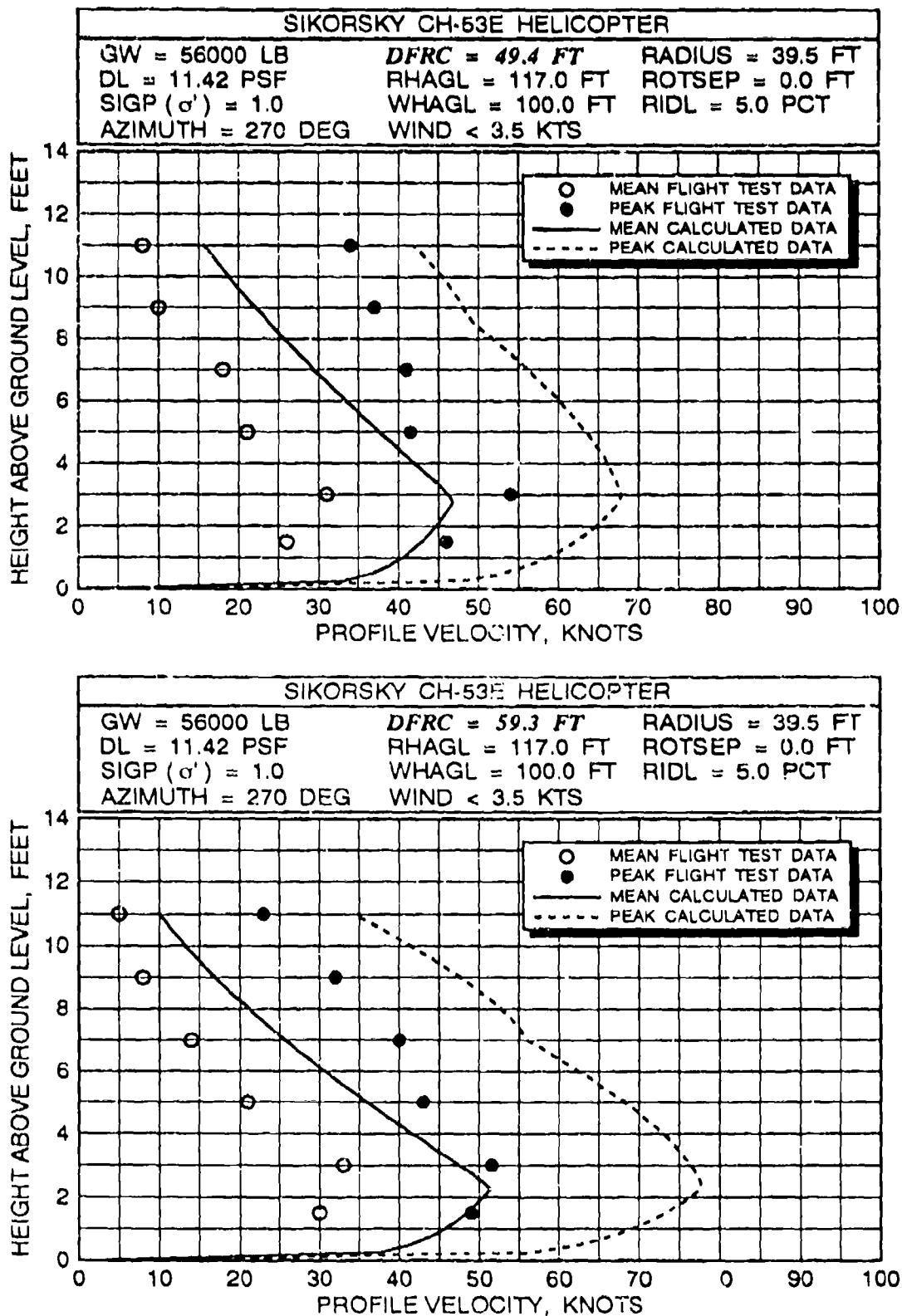
**FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**



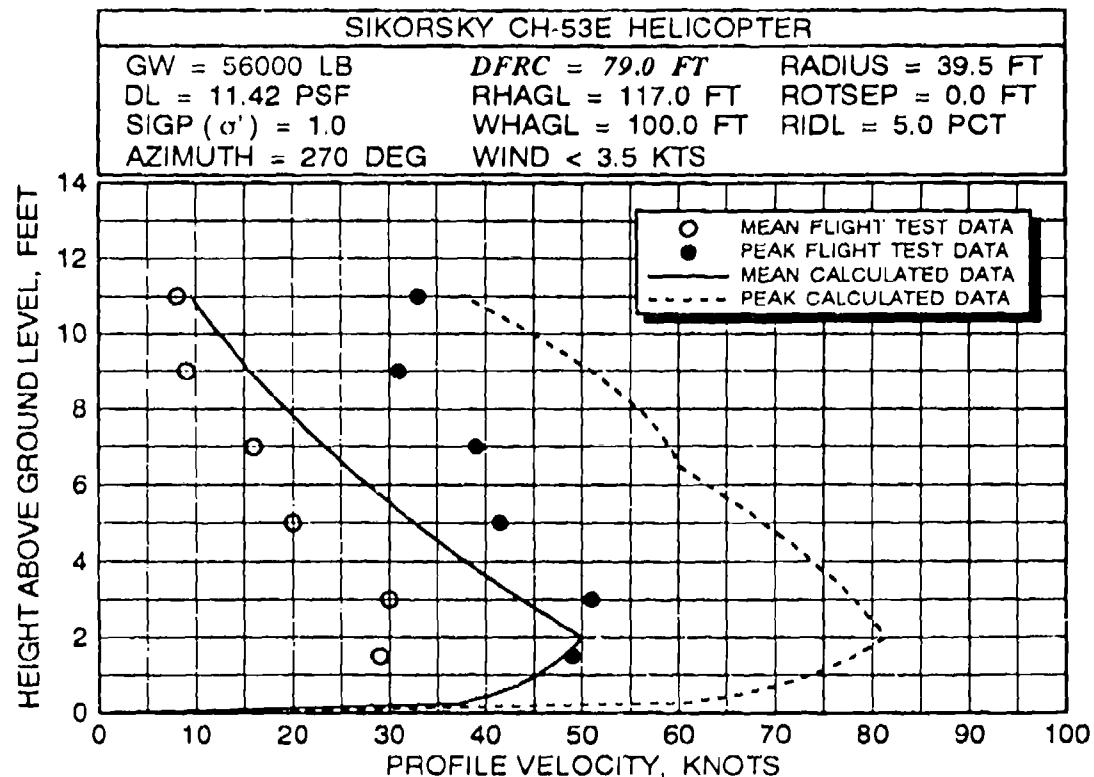
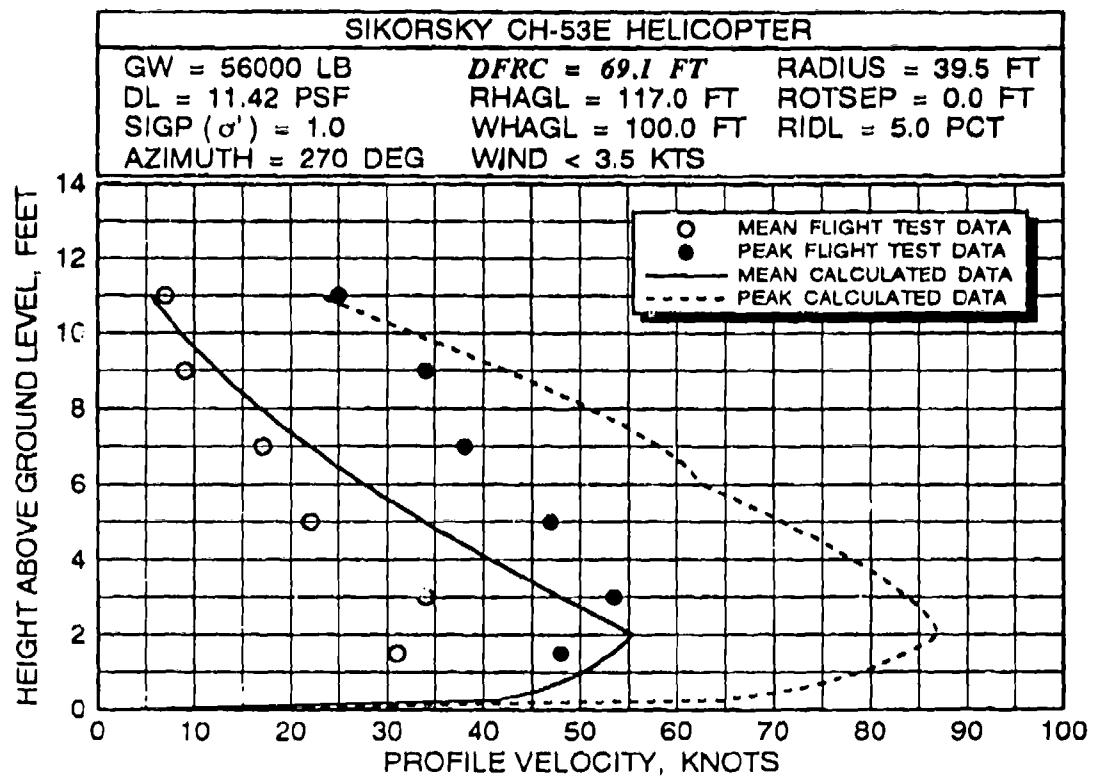
**FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**



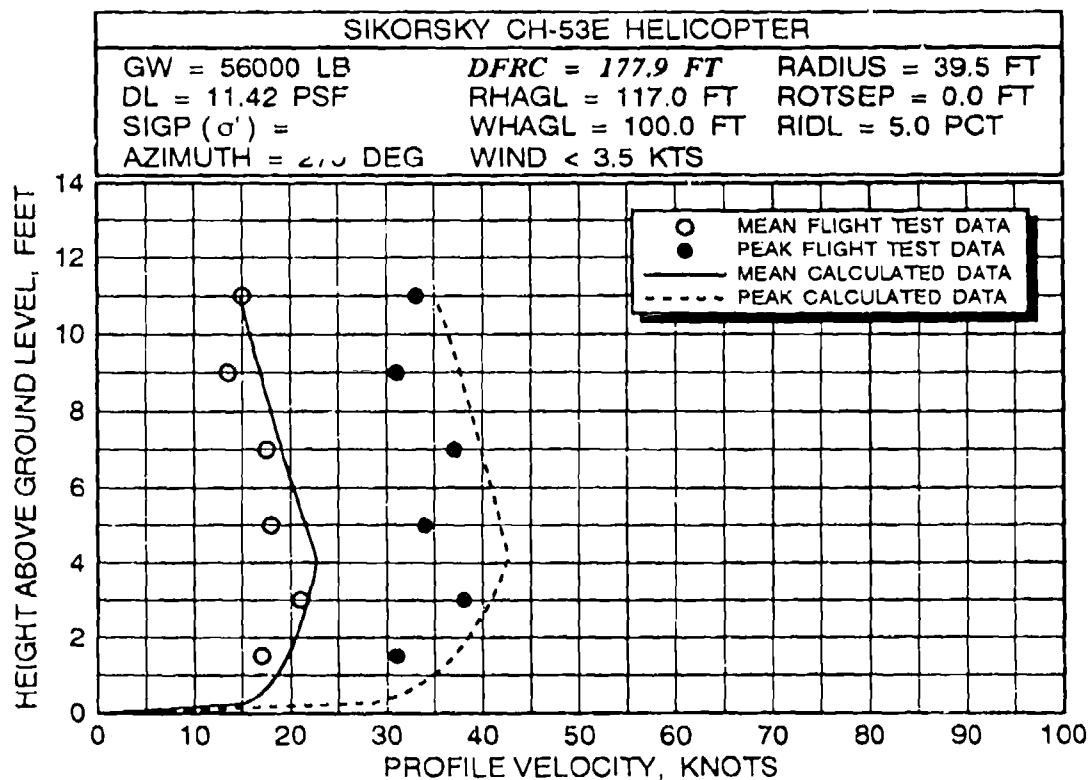
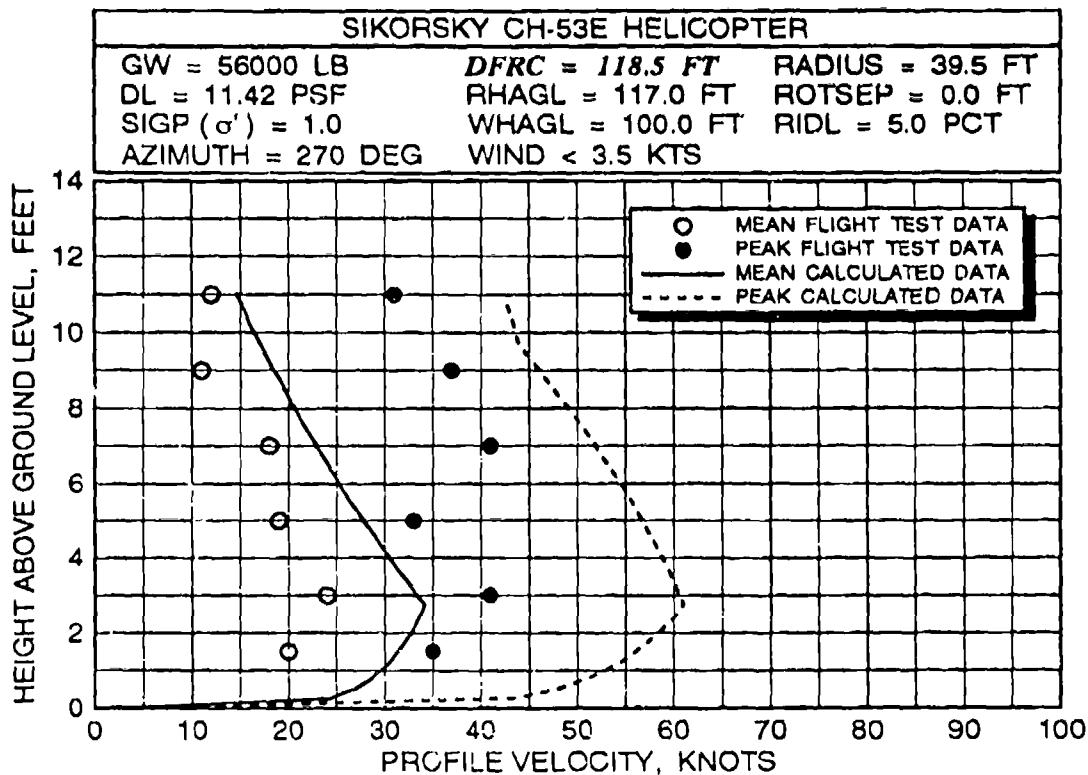
**FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A CROSS WEIGHT OF 56,000 POUNDS**



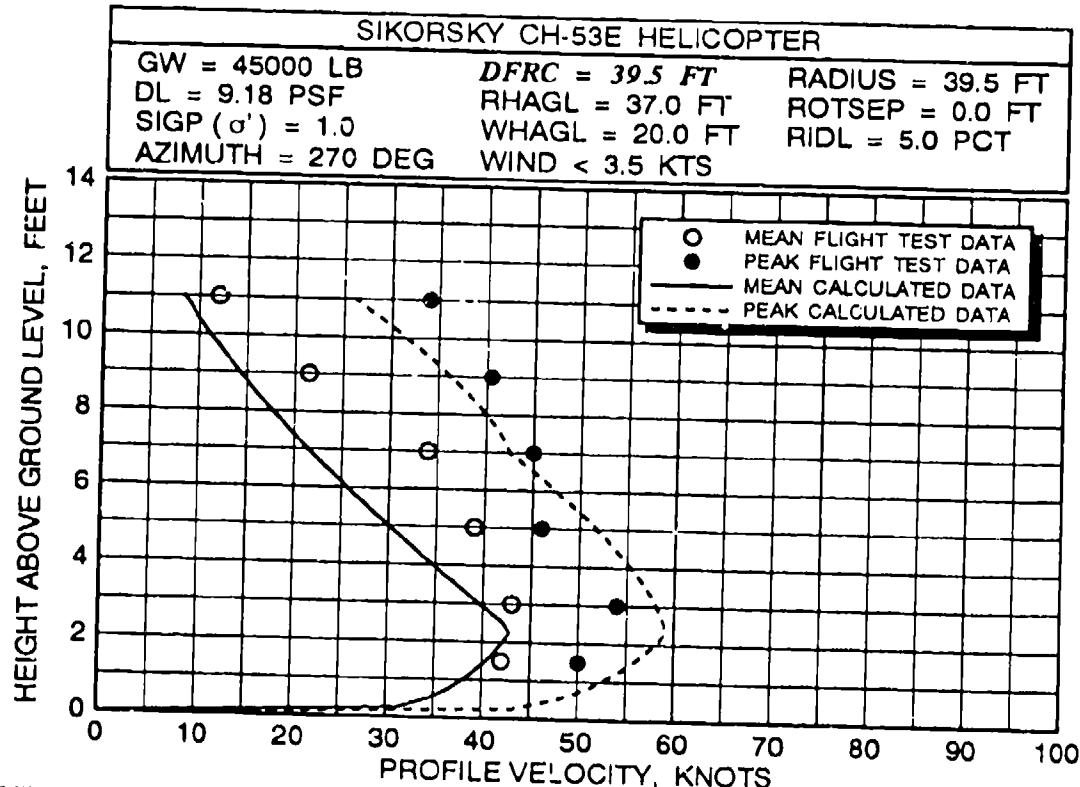
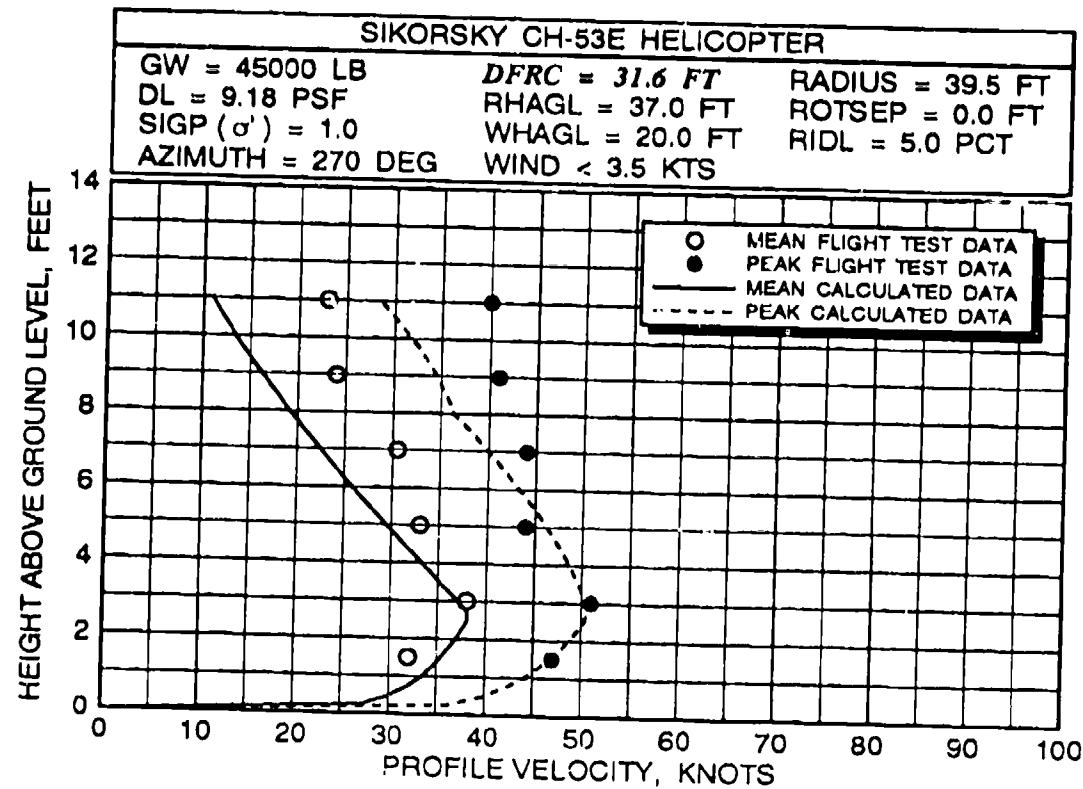
**FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)**



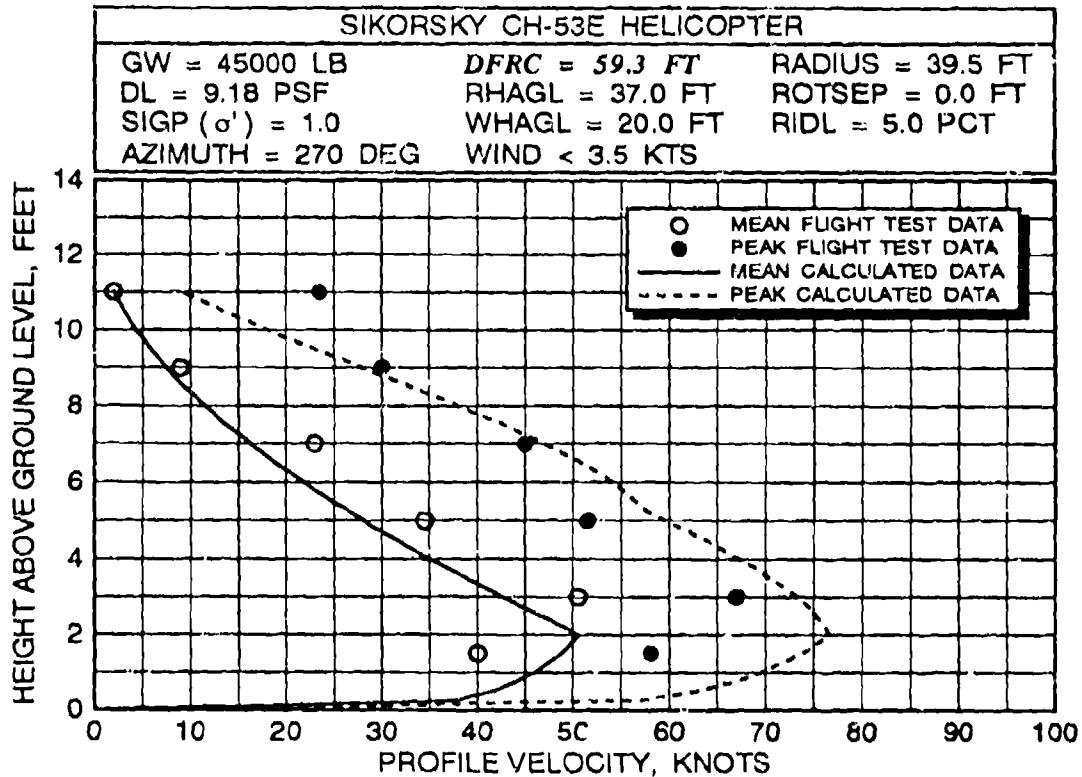
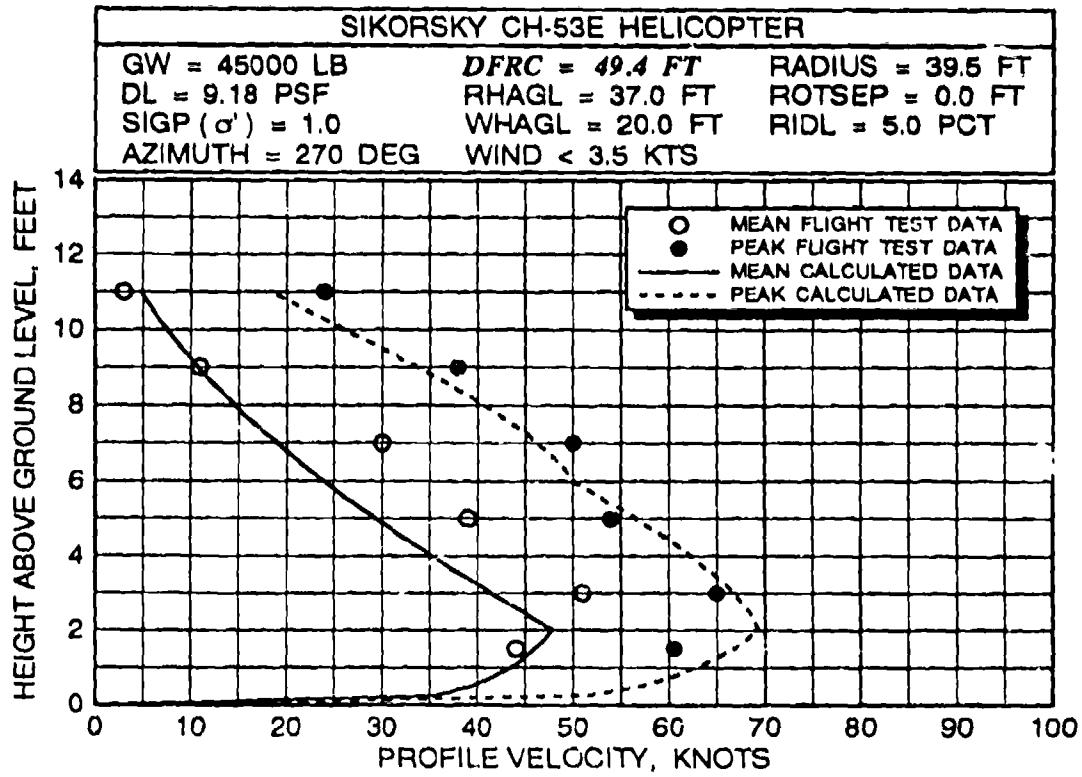
**FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



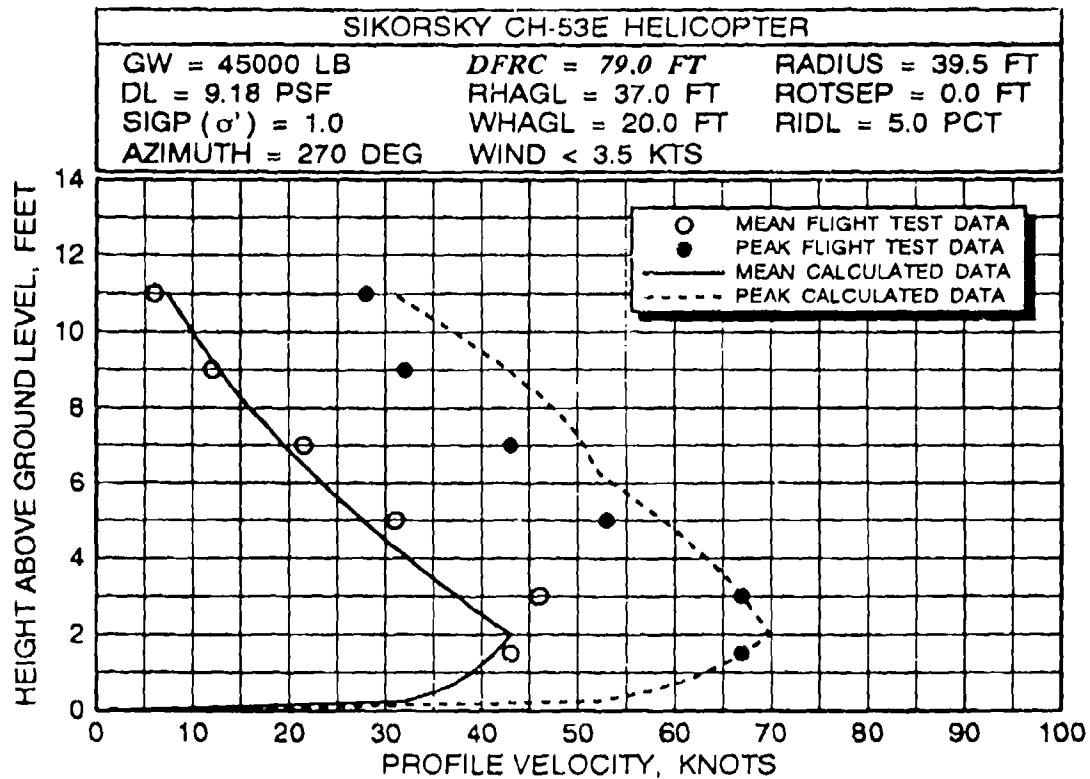
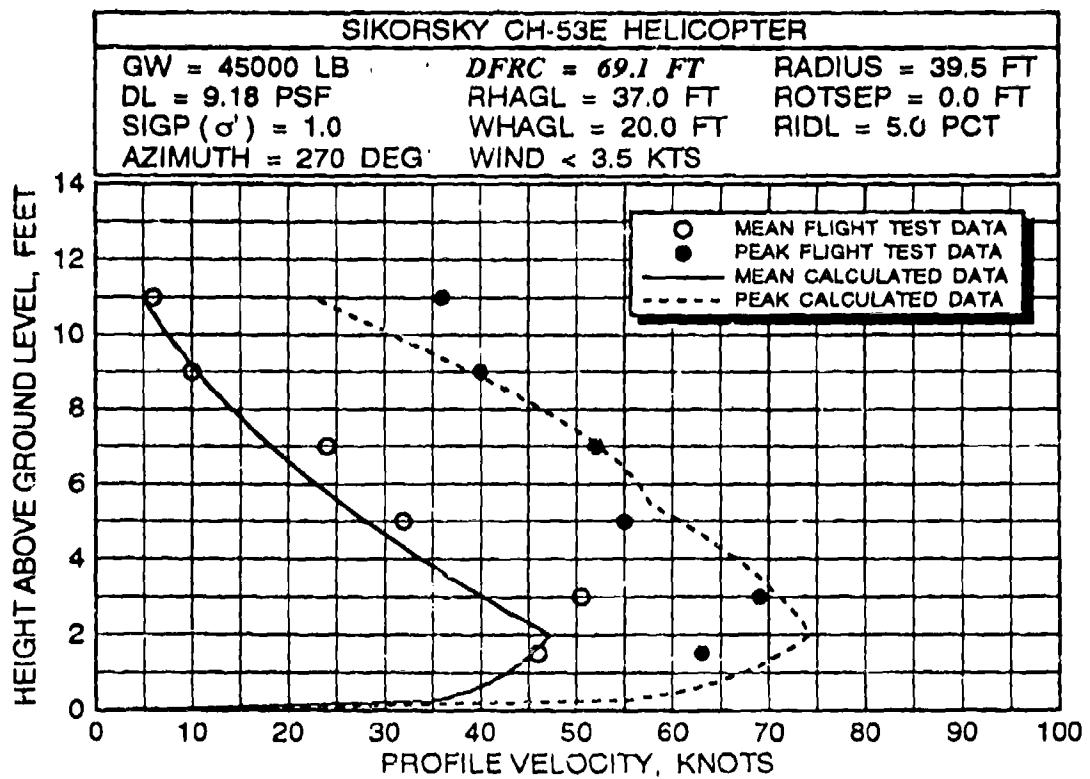
**FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



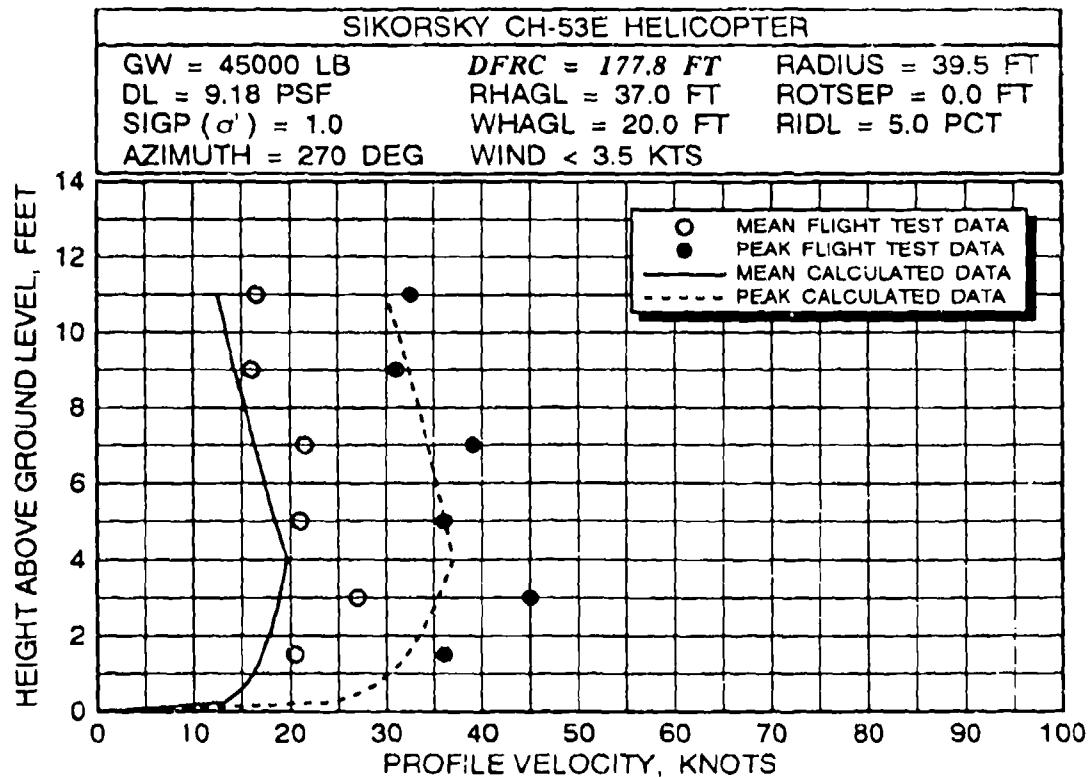
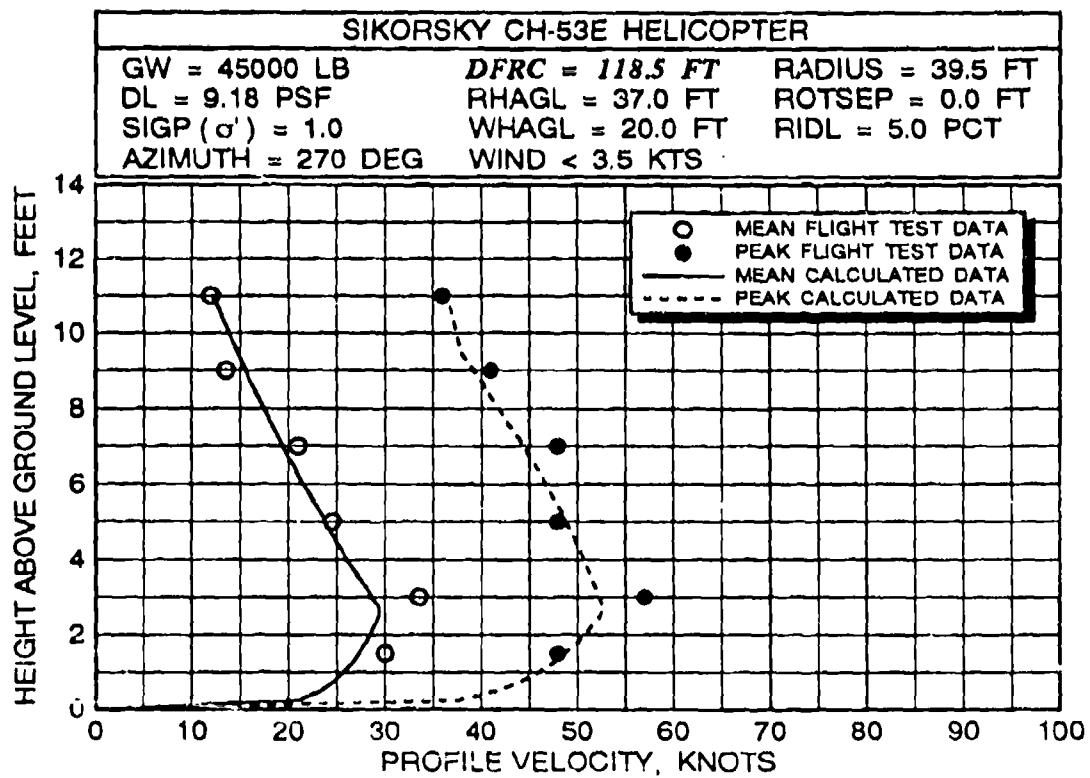
**FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS**



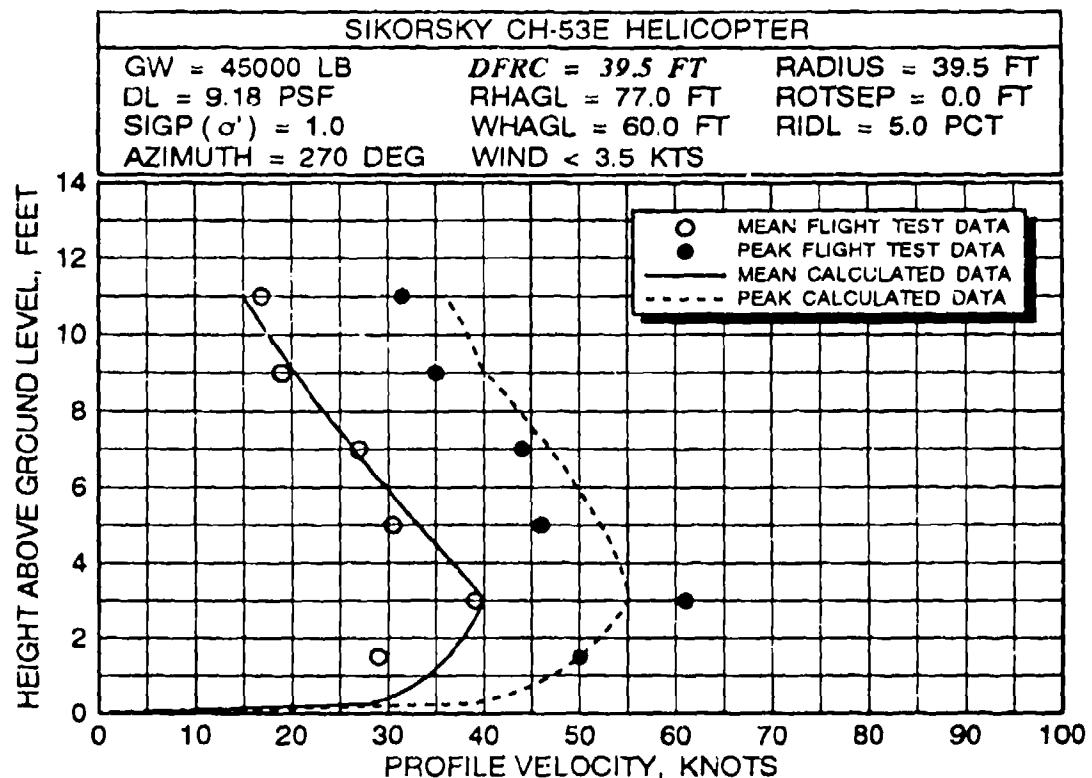
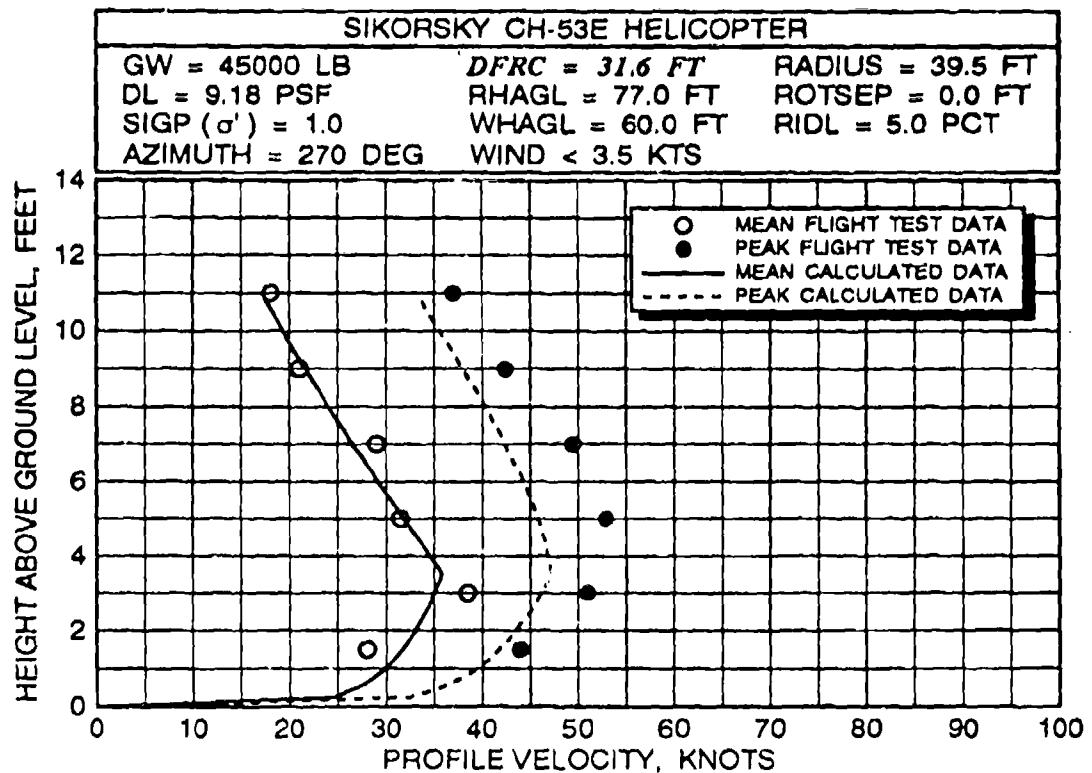
**FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



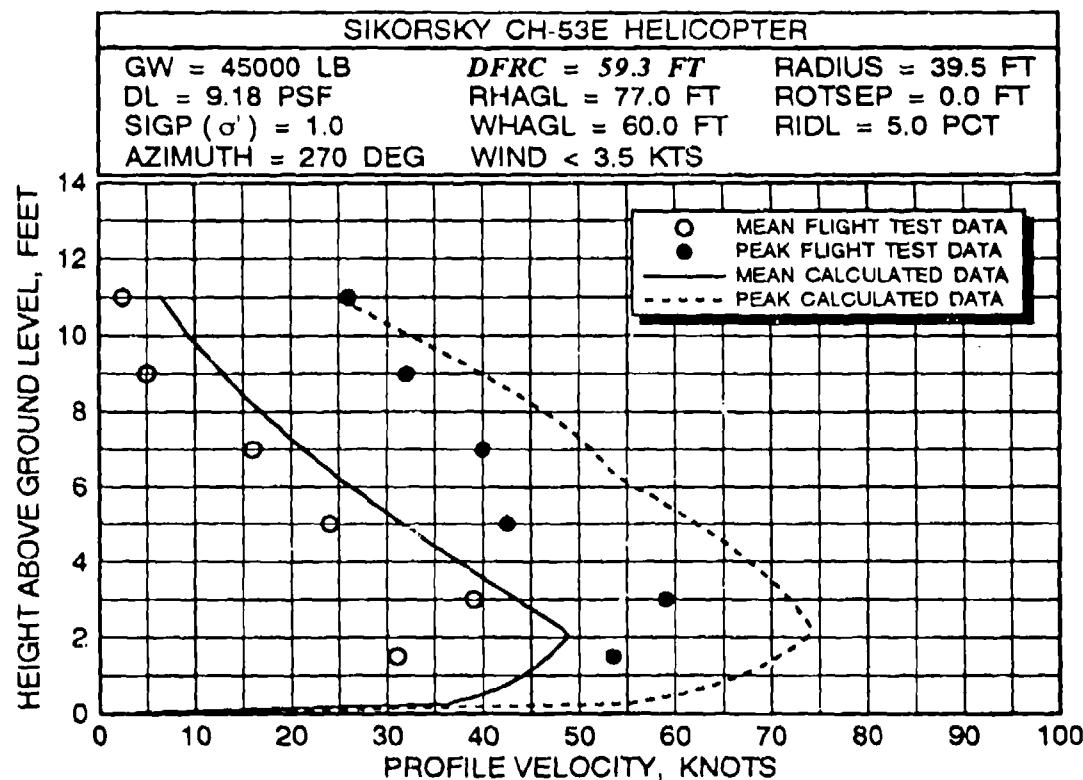
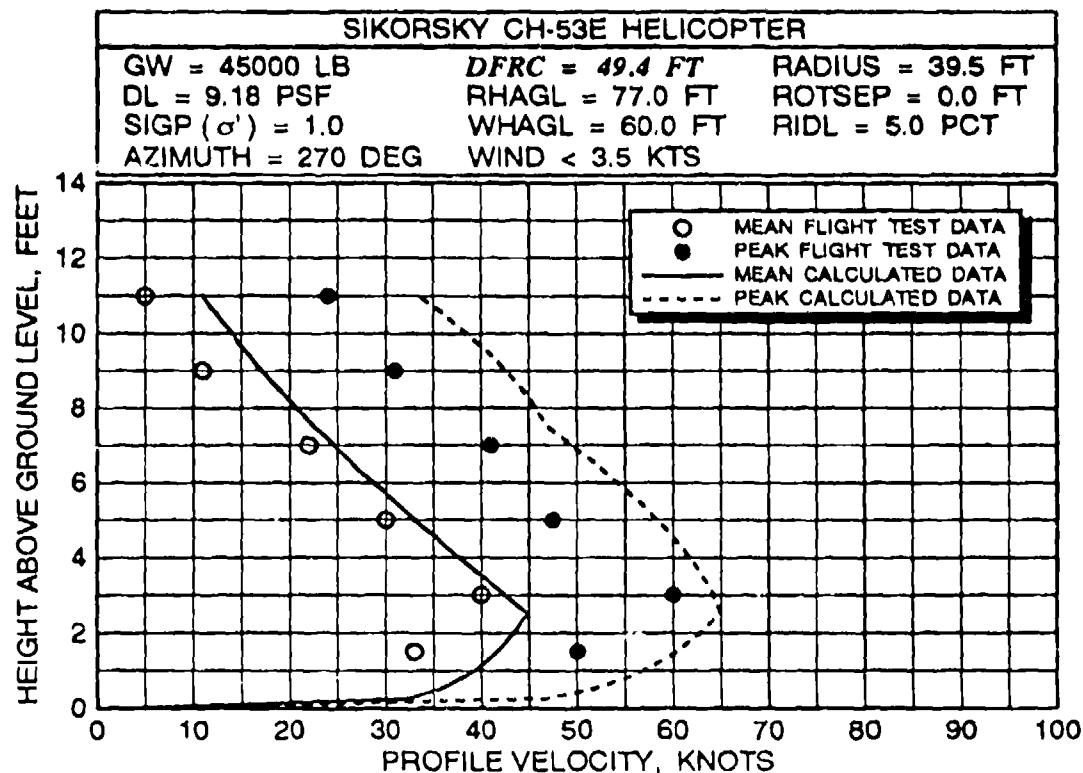
**FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



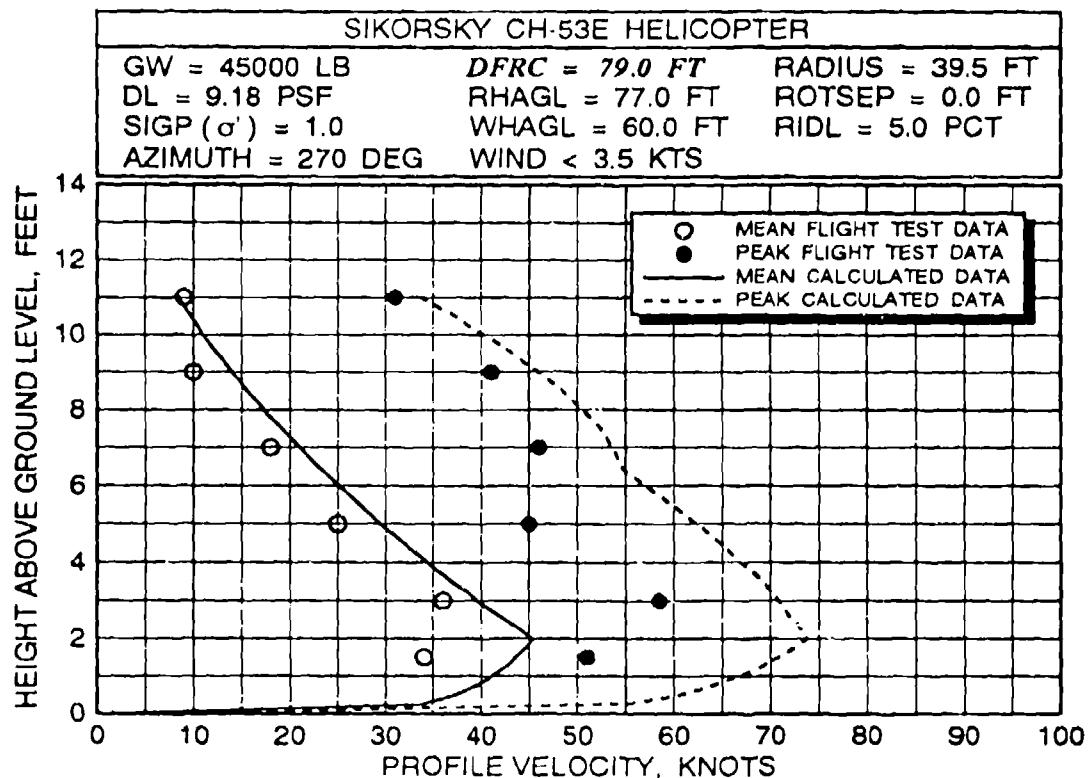
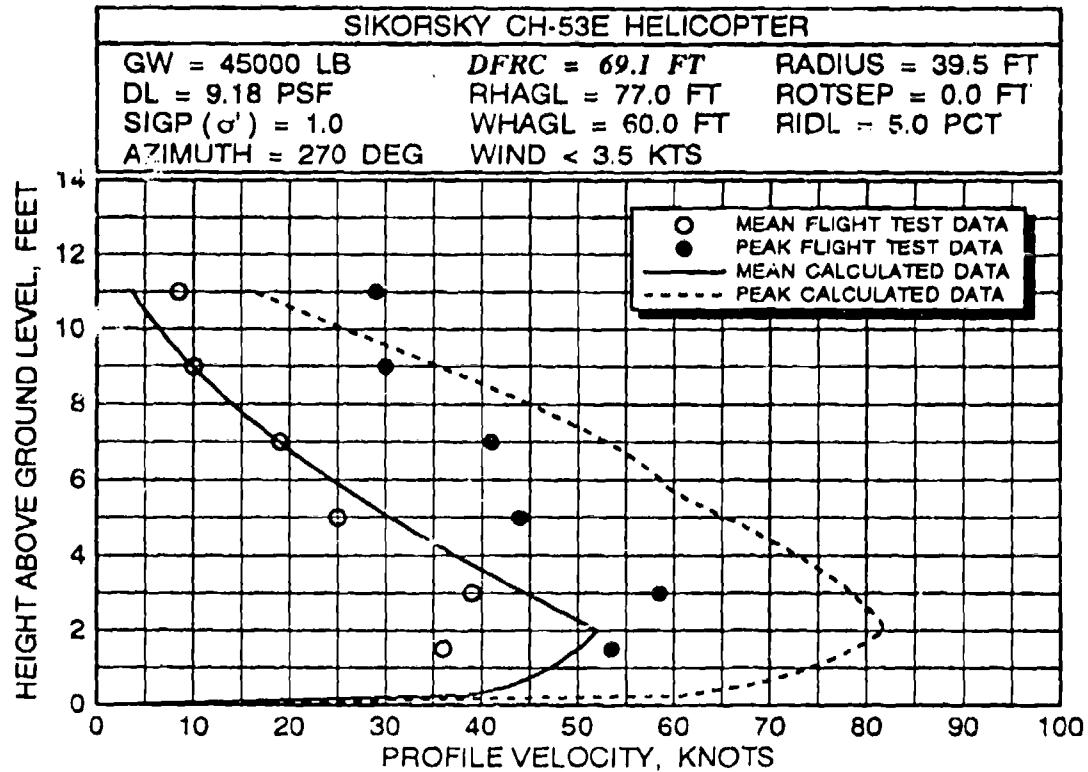
**FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



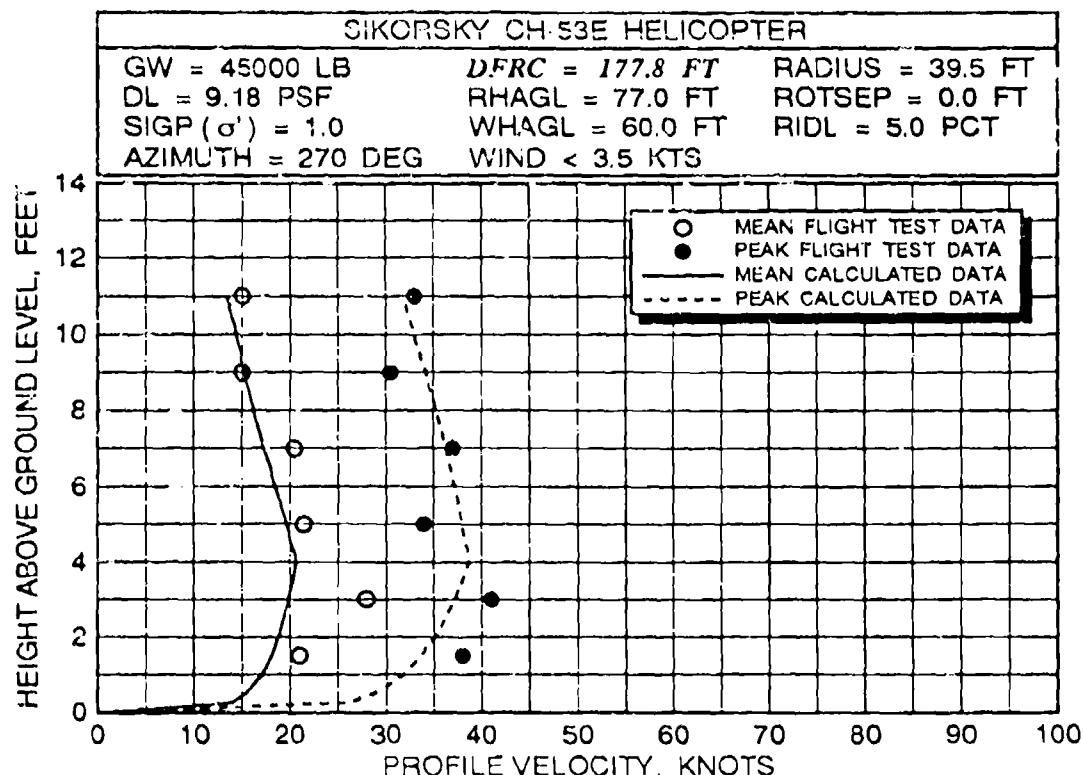
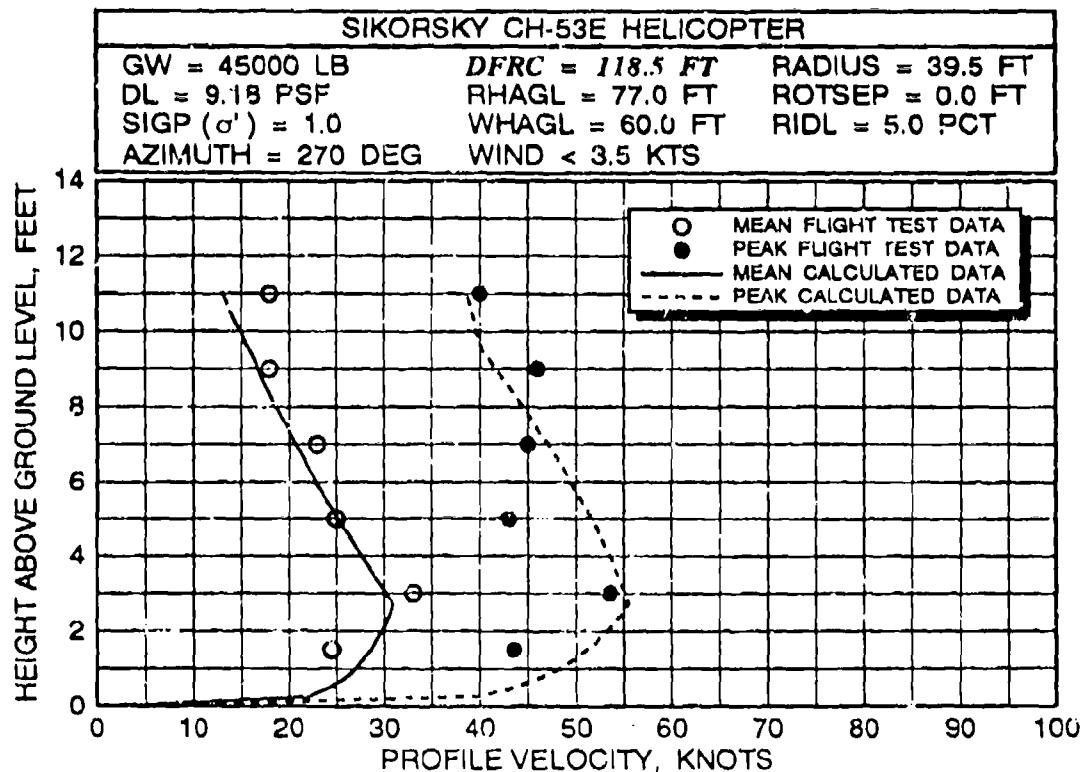
**FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS**



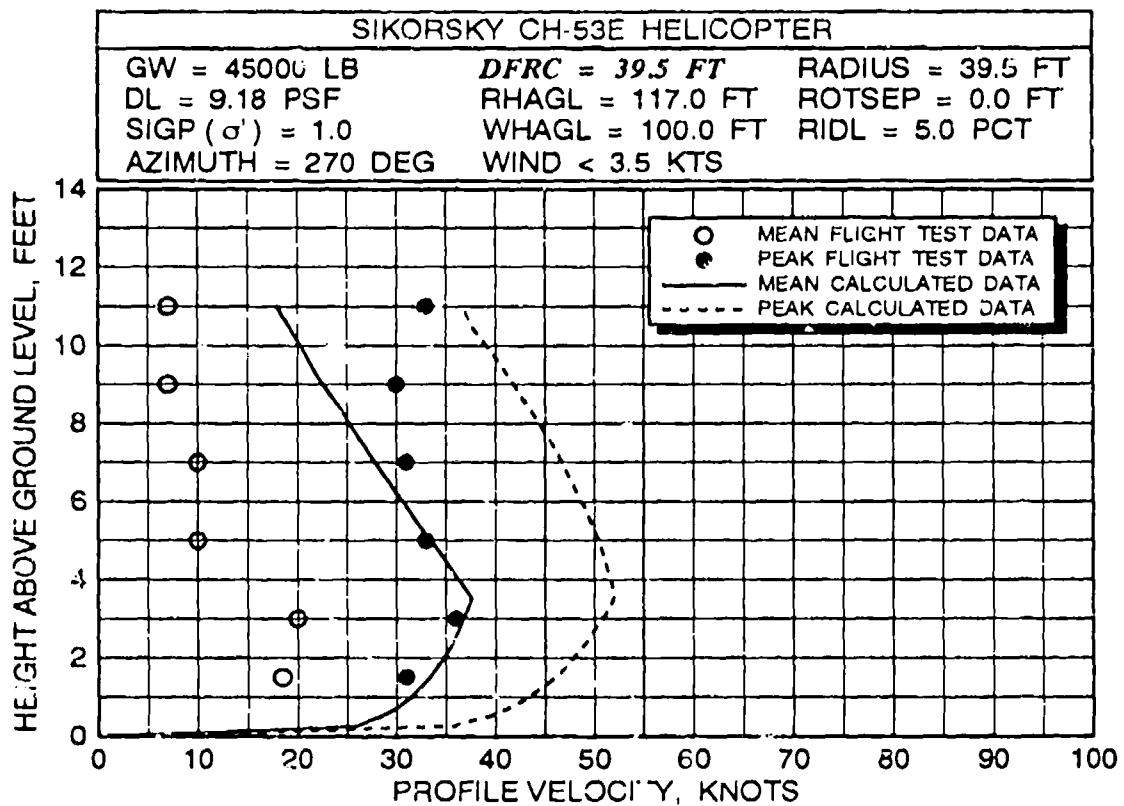
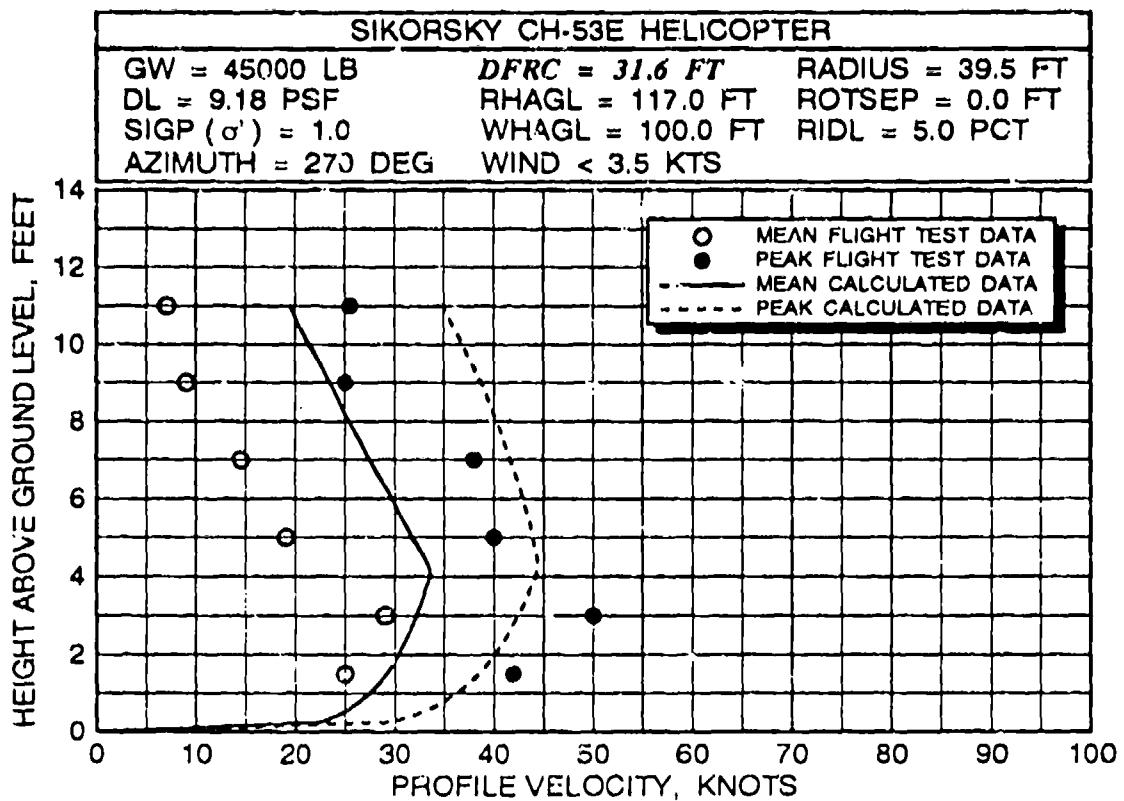
**FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



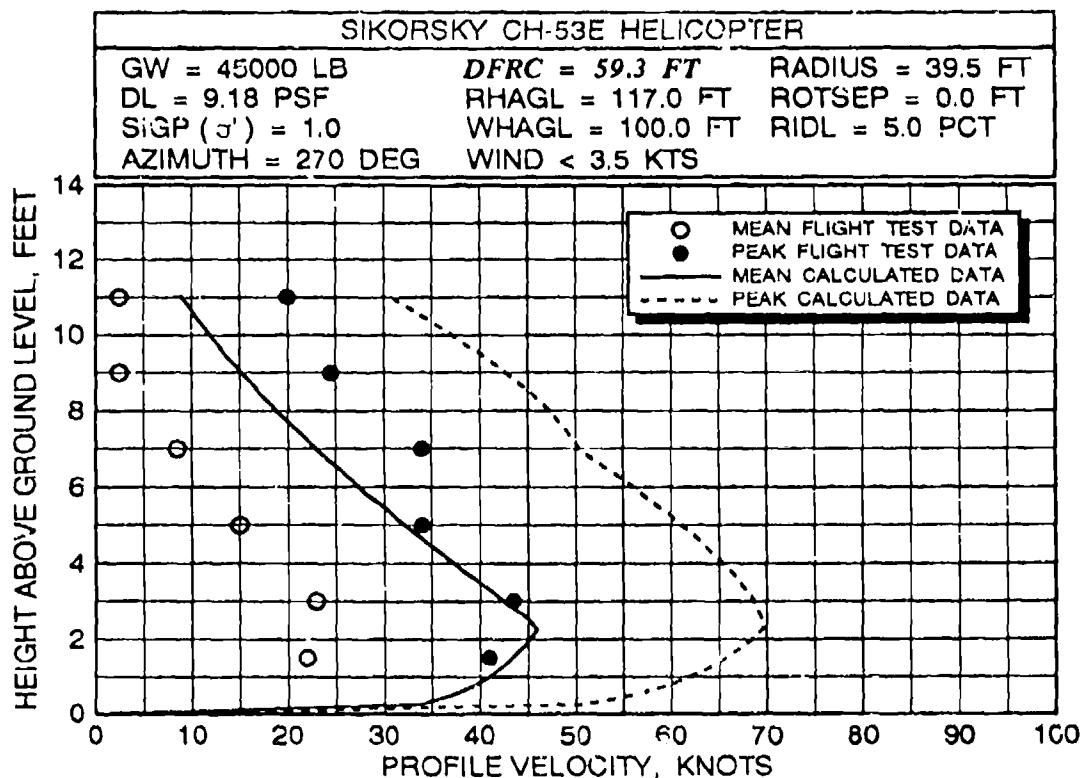
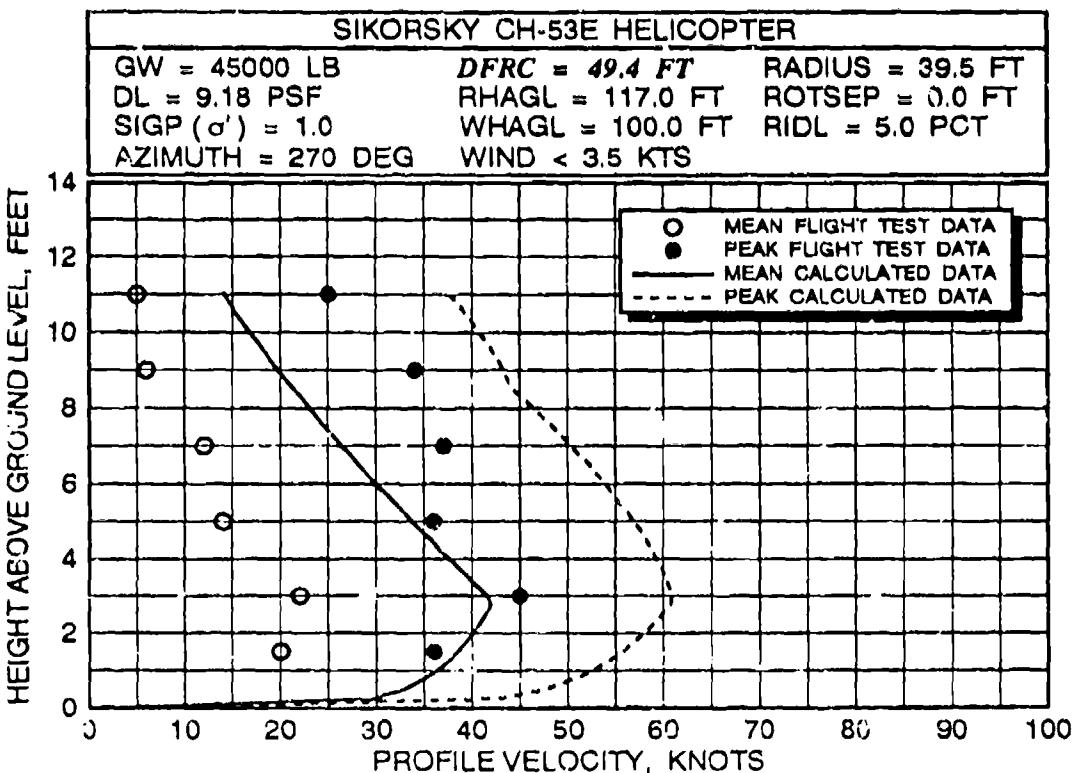
**FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



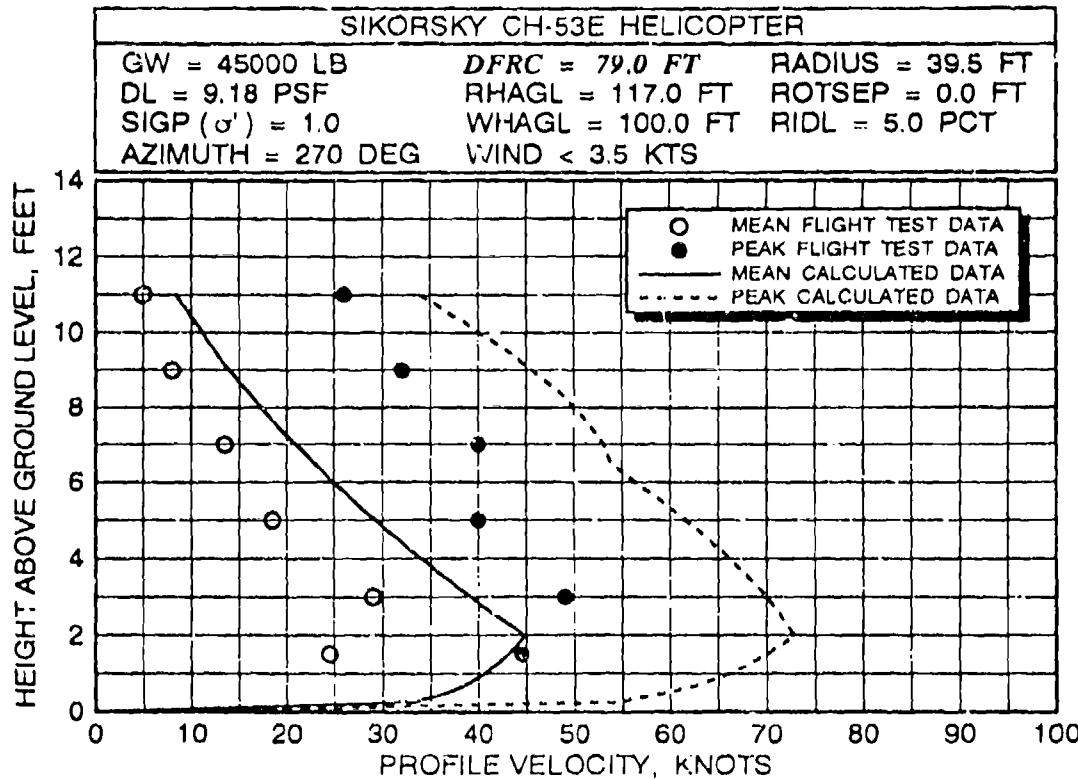
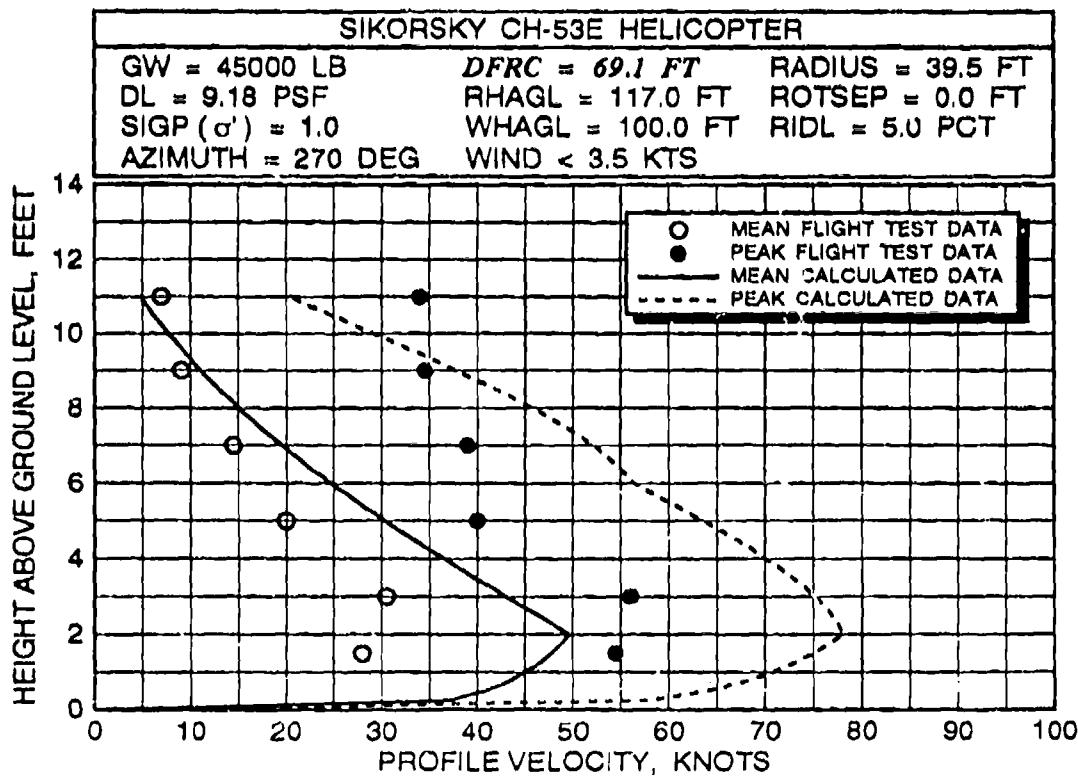
**FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



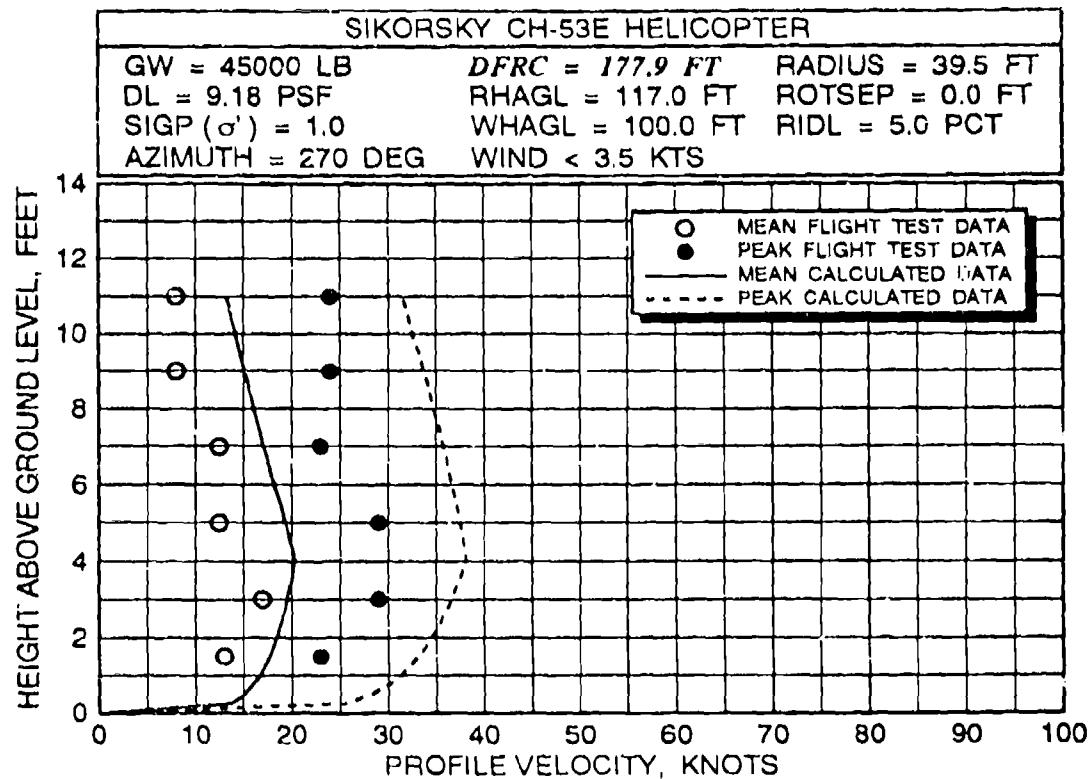
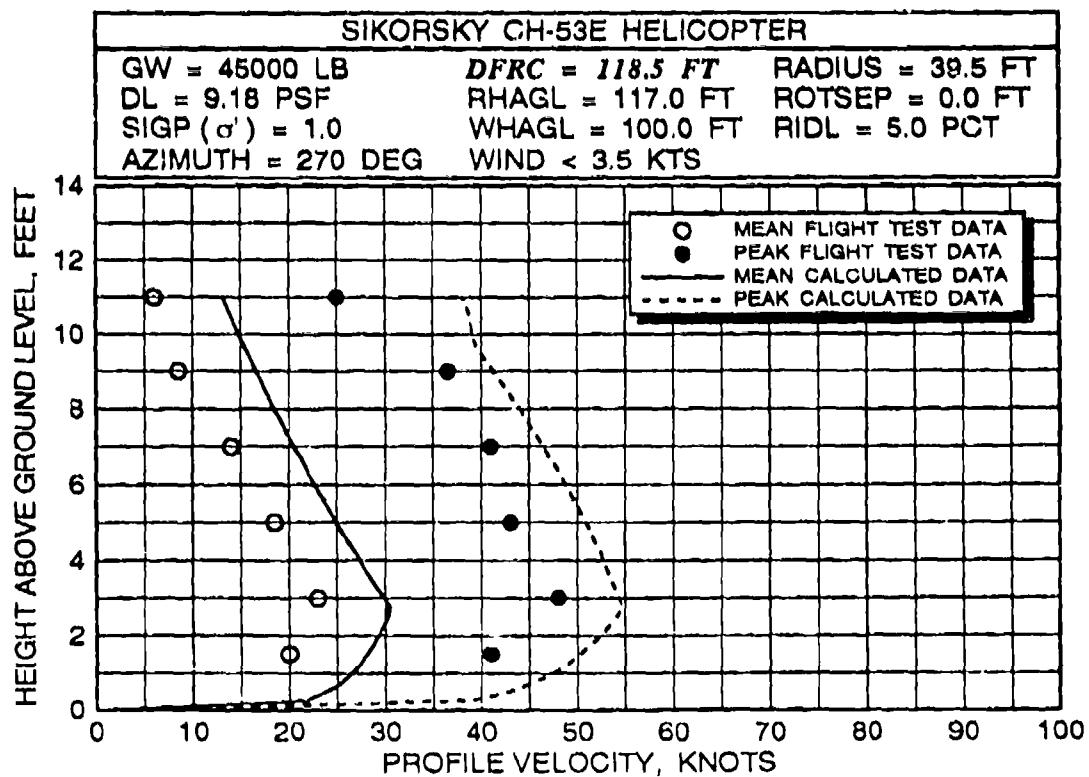
**FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS**



**FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



**FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270- DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**



**FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270° DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)**

## APPENDIX C

### A COLLECTION OF REFERENCES PROVIDING INFORMATION OR FURTHER INSIGHT INTO THE ROTORWASH HAZARD ANALYSIS PROBLEM

#### FULL SCALE AND MODEL DOWNWASH/OUTWASH FLOW FIELD DATA

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## APPENDIX D USER'S GUIDE

### D.1 ROTWASH PROGRAM USER'S GUIDE

The style of the ROTWASH user's guide presented in this appendix is primarily narrative. This format is designed to guide the reader through a step-by-step explanation on the use of each program software option. Example output from each option is presented exactly as it would be viewed by the user on a video terminal for reference purposes. Examples of user keyboard input are presented in **<BOLD>** text as an aid to the reader.

#### D.1.1 GETTING STARTED

The ROTWASH program is executed by typing the program name at the DOS system prompt:

**<ROTWASH>**

To avoid possible system errors, the user should execute the program from the directory containing the program (or set the appropriate DOS system PATH command). The user should also be aware that menu and data printouts to the screen will not work correctly unless the **device=C:\DOS\ANSI.SYS** command is contained in the CONFIG.SYS file.

The ROTWASH program responds with the screen output presented in figure D-1. This output is the ROTWASH program header page.

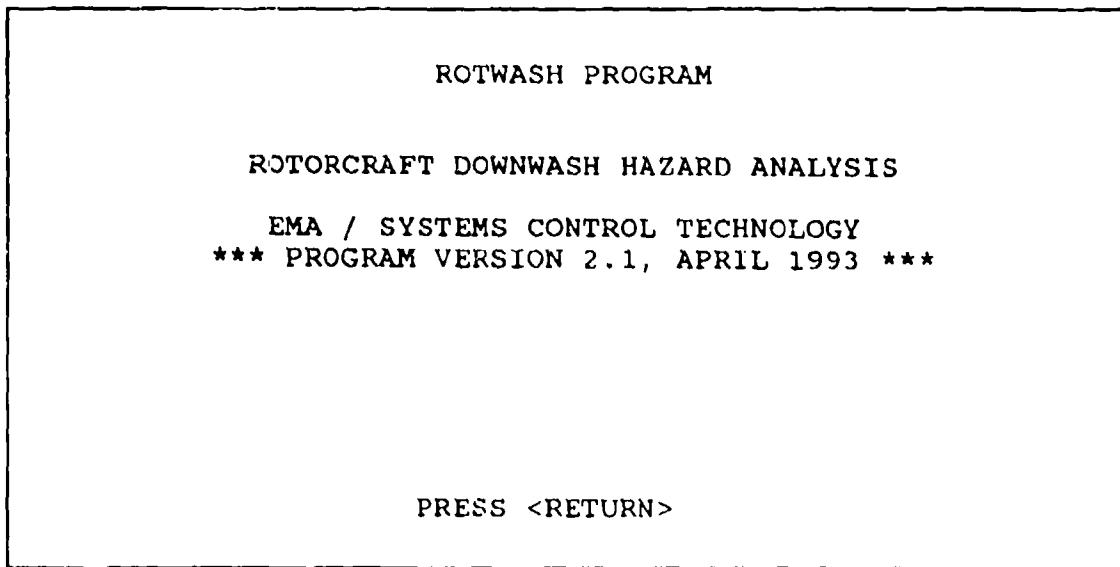


FIGURE D-1 ROTWASH PROGRAM HEADER OUTPUT

After typing the carriage return <RETURN> or <ENTER> key, the user is asked to specify the path for ROTWASH program input and output (I/O). The only option for input at the present time is the terminal keyboard. This is specified by typing <CON> for console or keyboard (lower case inputs such as <CON> are also permitted). Program output may be sent to one of three different locations. These output locations are:

<u>OUTPUT OPTION</u>	<u>TYPPING COMMAND</u>
Screen	<CON>
Printer	<PRN>
Disk Plotting File	<PLT>

An example of the video screen output for this program menu is presented in figure D-2 where the <CON> option has been chosen for both input and output.

```
I/O CAN BE DIRECTED TO FILES OR DEVICES
VALID DEVICES ARE AS FOLLOWS:
<CON> ==> CONSOLE
<PRN> ==> PRINTER
<PLT> ==> GRAPHICS FILE

ENTER INPUT FILE/DEV NAME ==> CON
ENTER OUTPUT FILE/DEV NAME ==> CON
```

FIGURE D-2 ROTWASH PROGRAM INPUT/OUTPUT CONTROL MENU

#### D.1.2 INPUT DATA REQUIREMENTS

Rotorcraft characteristics and atmospheric conditions that are common to all program options are input to the program using the master input data menu. Four basic configurations of rotor or propeller driven aircraft can be represented using this menu. These configurations include single and tandem rotor helicopters, tiltrotors, and twin-propeller tiltwings. This menu is presented to the user as shown in figure D-3 after the I/O menu is completed. The default values provided in the menu define the Bell XV-15 tiltrotor. Design data describing most other modern types of rotorcraft are provided in appendix A.

ROTWASH USER INPUT DATA MENU			
CODE	PARAMETER	VALUE	UNITS
A	NUMBER OF ROTORS (1 OR 2)	2	-ND-
B	HUB TO HUB ROTOR SEPARATION	32.2	FT
C	ROTOR RADIUS	12.5	FT
D	GROSS WEIGHT	13000.0	LB
E	FUSELAGE DOWNLOAD FACTOR	13.0	PCT
F	ROTOR HEIGHT ABOVE GROUND	37.0	FT
G	SHAFT TILT ANGLE (<20 DEG)	.0	DEG
H	AIR DENSITY RATIO	1.0000	ND
I	AMBIENT WIND (-10 TO 10 KT)	.0	KT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> D

GROSS WEIGHT = 13000.0

ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS ==> 13500.0

#### FIGURE D-3 MASTER INPUT DATA MENU

The first input data variable listed on the menu is the number of rotors (or propellers). This value will always be two except for single main rotor helicopters (the tail rotor is not considered a lifting rotor by the ROTWASH analysis). The next four menu variables define the design details of the rotorcraft configuration. These variables are the hub-to-hub separation distance for twin-rotor configurations (in feet), rotor radius (feet), rotorcraft gross weight (pounds), and the rotor-on-wing download factor (percent). The download factor represents the percent increase in hover rotor thrust required to overcome the rotor-induced vertical drag force on the airframe (where thrust is initially assumed to equal gross weight). For most helicopters, this value is less than 5 percent. Download on tiltrotors can generally be expected to vary from 8 to 13 percent because of the large wing area under the rotor.

The next two input data variables define the position of the rotor with respect to the ground plane. The rotor height (feet) is defined as the distance from the ground surface to the plane of the rotor. The mast angle (degrees) is defined as the tilt of the rotor plane with respect to the ground plane. The mast angle is defined as 0 degrees when the plane of the rotor is parallel to the ground plane and a positive angle is a forward tilt of the mast (which is presently limited in the program to 20 degrees). Since most rotorcraft hover with the plane of the rotor parallel to the ground, it is recommended that caution be exercised when non-zero values are used for mast angle. Non-zero uses of the variable might involve hover investigations for tiltwing aircraft

with the wing tilted forward (where a pitch fan provides the trim pitching moment). Also, limited rotorwash investigations for takeoff and landing maneuvers might be attempted if approximate rotor thrust levels are known for various segments of the maneuvers.

The last two input data variables on the menu define the atmospheric conditions. The air density ratio is defined as the ratio of the desired air density to the sea level standard air density (0.0023769 slugs/feet<sup>3</sup>). Ambient wind speed (knots) is specified by the user up to a limit of 10 knots. Values greater than this limit are believed to invalidate several empirically determined mathematical modeling assumptions (limits are discussed in sections 2 and 3 of Volume I of this report).

The mechanics of using the menu are quite simple. The user types in the code value for the variable to be changed and then types <RETURN>. The next prompt asks for the new parameter value. After this value and another <RETURN> are typed, the menu is rewritten to the screen with the new value. This simple process is continued until the user specifies each variable to its desired value. At this point, the <RETURN> key is typed by itself. This menu can also be reached from most of the other menus in the program whenever the user decides that the basic configuration needs to be modified. This is accomplished by typing <N> for NEW CASE when the option is offered.

#### D.1.3 ANALYSIS PROBLEM DEFINITION

After the master input data menu is completed, the user specifies the desired type of analysis option. Figure D-4 presents the program logic/comment menu and the associated list of default values. This menu has two groupings of parameters which need to be specified.

The first parameter on the menu specifies the choice of either the velocity calculation analysis option or the hazard analysis option. The velocity analysis option is the default option on the menu. This option is otherwise chosen by typing the code <A>, then <RETURN>, then <V>, and finally <RETURN>. The same process is used to specify the hazard analysis option except that <H> is substituted for <V> as the parameter value. The second menu parameter provides an interactive toggle switch for the option which writes out data files to disk for graphics programs. (This parameter is also offered as an option on the initial ROTWASH menu by typing <PLT>). There is no limit to the number of times this switch can be toggled. As long as the parameter has a <Y> or "yes" value, the user must specify output filenames before data files are written to disk. The user is not allowed to write over files previously written to disk by specification of the same filename twice.

### ROTWASH PROGRAM LOGIC/COMMENT MENU

CODE	PARAMETER	VALUE
A	ANALYSIS TYPE,      <V> OR <H>	V
B	GRAPHICS FILE,      <Y> OR <N>	N
USER INPUT COMMENTS (FOR "PRN" AND "PLT" OUTPUT)		
C	<--- 50 SPACES --->	
C	XV-15 CHARACTERISTICS ARE USED AS INPUT DATA	
D	GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS	
ENTER CODE FOR DATA INPUT OR <RETURN> TO CONTINUE ==>		

**FIGURE D-4 ROTWASH PROGRAM LOGIC/COMMENT MENU**

The last two lines in the menu are used to specify user comments in all data files that are written to disk. These comments are also written out as header information on screen output sent directly to the printer. Both of the comment lines can be changed at any time during program execution. The only restriction is that the character strings on both lines be less than or equal to 50 characters. The arrowhead symbols above the comment lines in the menu define a 50-space line width.

If the velocity analysis option is specified, the user is then required to choose one of the four analysis options presented in figure D-5. Velocity analysis options reached through this menu are the:

1. simple wall jet (for both single and twin-rotor configurations),
2. interaction plane (twin-rotor only),
3. ground vortex (single rotor only), and
4. disk edge vortex (single rotor only).

SELECT TYPE OF FLOW TO BE ESTIMATED

WALL JET PROFILE,	TYPE <W>
INTERACTION PLANE PROFILE,	TYPE <J>
GROUND VORTEX,	TYPE <G>
DISK VORTEX,	TYPE <D>
TO EXIT PROGRAM,	TYPE <X>

ENTER DATA ENTRY CODE ==> W

FIGURE D-5 VELOCITY ANALYSIS OPTION MENU

Each of these four options is described with flowfield characteristics sketches in subsequent sections. For technical details and discussion on practical limitations of these options, the user is referred to Sections 2 and 3 of Volume I of this report. The choice of one of these menu options is made by typing the appropriate code and <RETURN>. If one of the five allowable characters is not chosen, the menu will reappear and the user will be forced to choose an acceptable option.

If the hazard analysis option is specified, the user is presented with the figure D-6 menu. This menu allows the user to choose either:

1. human overturning force/moment analysis, or
2. particulate cloud analysis.

Both of these analyses can be applied to either single or twin-rotor configurations. The mechanics of this menu operate exactly like those of the velocity analysis option menu.

#### D.1.4 THE WALL JET OPTION

Rotorwash velocity profiles are calculated for single main rotor helicopter configurations using the wall jet option. Velocity profiles along the 0- and 180-degree azimuths for tandem helicopters and the 90- and 270-degree azimuths for twin-rotor side-by-side configurations are also calculated using this option (90 degrees is out the right wing on a tiltrotor and 0 degrees is along the centerline of the fuselage for tandem rotor helicopters). Figure D-7 provides a three-dimensional view of

SELECT TYPE OF HAZARD

OVERTURNING FORCE/MOMENT,	TYPE <M>
PARTICULATE CLOUDS,	TYPE <C>
TO EXIT PROGRAM,	TYPE <X>

ENTER HAZARD CODE ==> M

FIGURE D-6 HAZARD ANALYSIS OPTION MENU

the rotorwash flowfields associated with both rotor configurations. Figure D-8 provides a cross-sectional view of the nondimensionalized ROTWASH wall jet velocity profile model. The program menu associated with the use of this option is presented in figure D-9.

The velocity profile status menu provides the user the option to specify four parameters before proceeding with detailed calculations. The horizontal distance on the ground from the center of the rotor to where the velocity profile should be calculated is the first parameter specified on the menu. Figure D-10 is provided to illustrate this geometry graphically using the Bell XV-15, which is the more complex example (flight test data results associated with this figure are documented in reference D-3). To specify the profile station position for the wall jet with the XV-15 (270-degree radial), the user would measure the distance from the aircraft centerline (DFAC) and subtract 16.1 feet (the distance from the centerline to the center of the rotor). The remaining two position-related parameters to be specified are the vertical calculation increment and the maximum height above ground level (AGL) to which the profile should be calculated. The default values for these three parameters are 50 feet, 1 foot, and 10 feet, respectively.

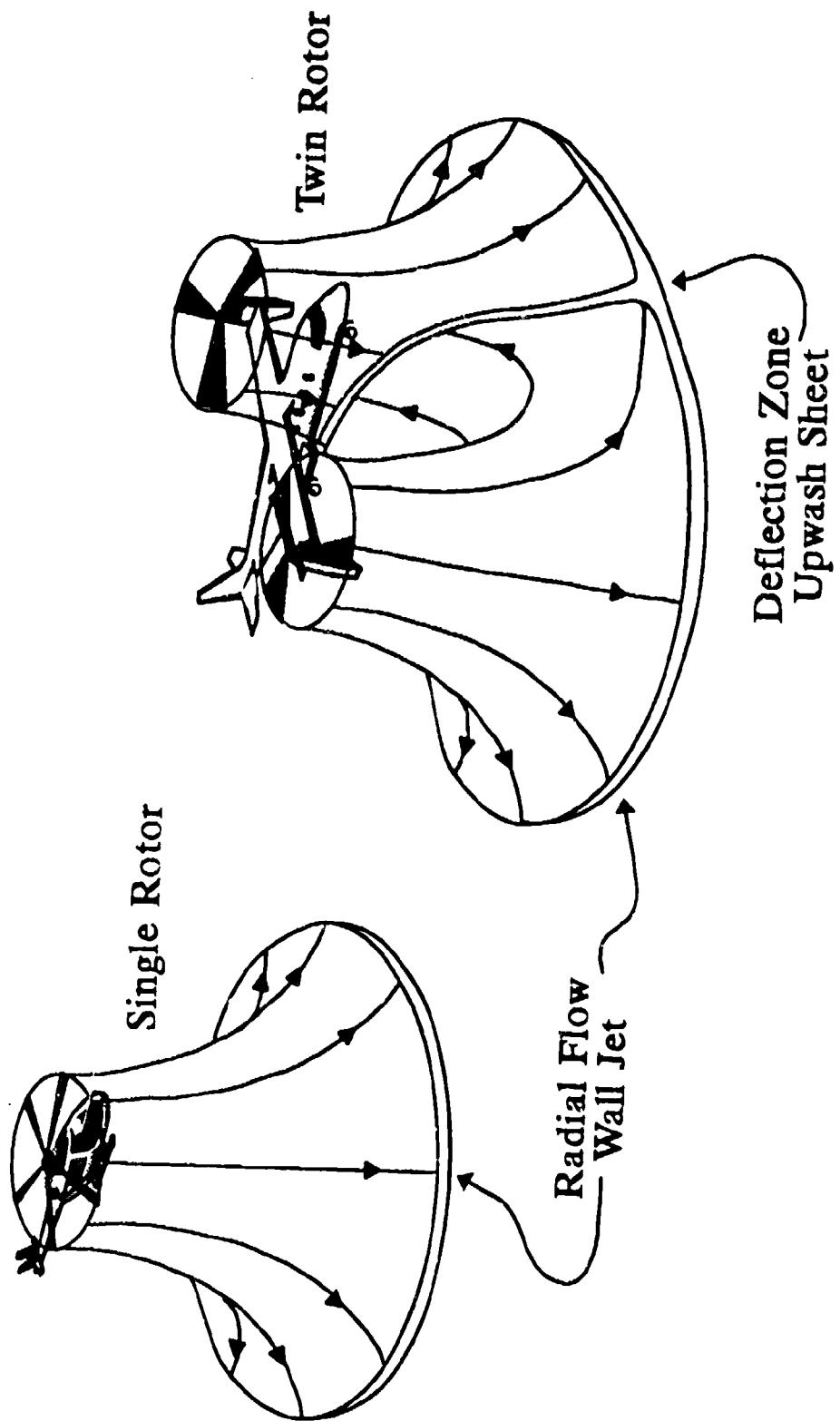


FIGURE D-7 ROTORWASH FLOW FIELDS OF SINGLE- AND TWIN-ROTOR CONFIGURATIONS OPERATING IN CLOSE PROXIMITY TO THE GROUND

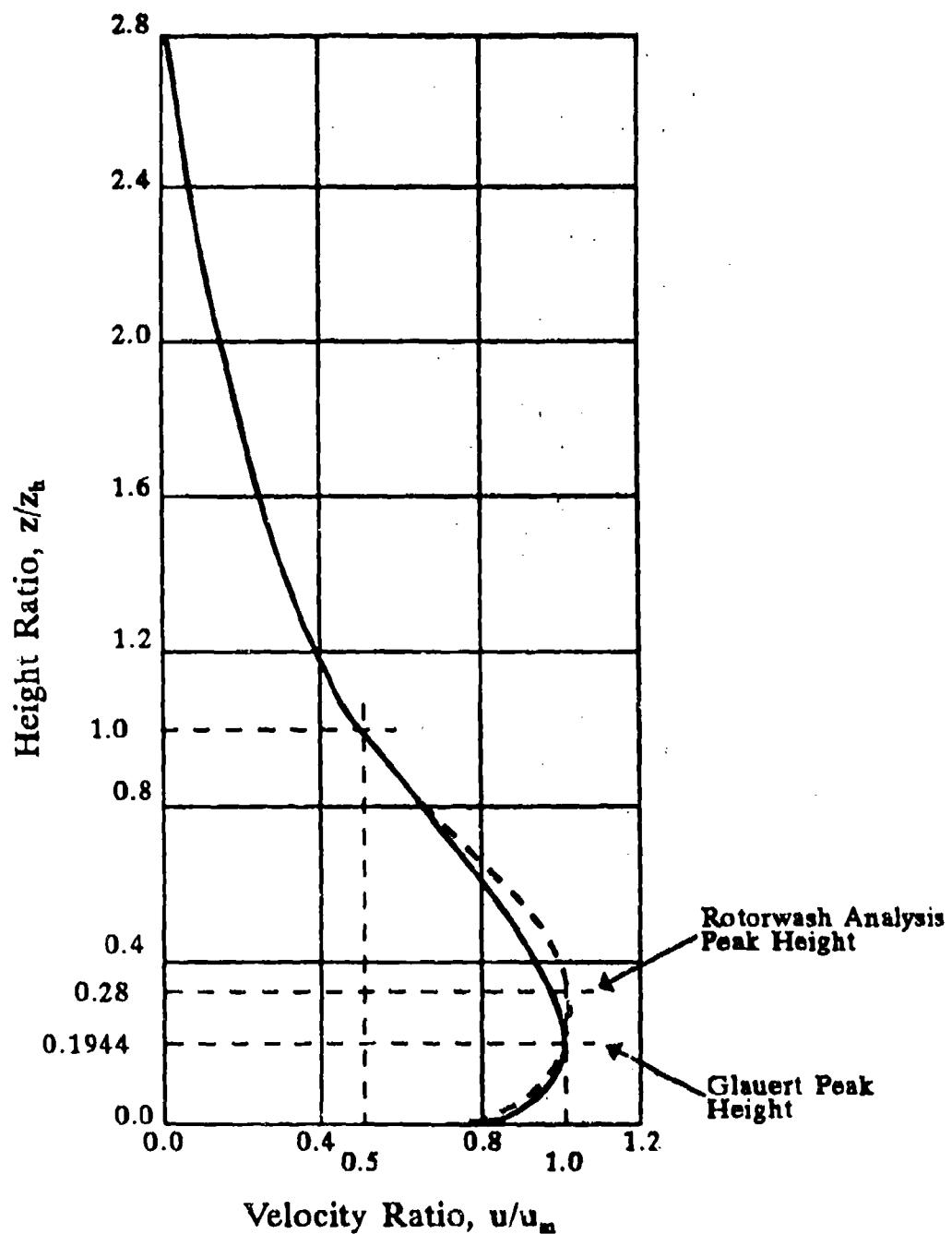


FIGURE D-8 NON-DIMENSIONAL WALL JET VERTICAL VELOCITY PROFILE

### VELOCITY PROFILE STATUS MENU

CODE	PARAMETER	VALUE	UNITS
A	PROFILE STATION POSITION	50.00	FT
B	VERTICAL INCREMENT	1.00	FT
C	MAXIMUM PROFILE HEIGHT	10.00	FT
D	MINIMUM BOUNDARY LAYER HEIGHT	1.50	FT
E	DATA OUTPUT FILENAME	DFRC.PTS	

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

**FIGURE D-9 VELOCITY PROFILE STATUS MENU**

An option is also provided to allow the user to specify a minimum boundary layer height based on flight test data. The default value of 1.5 feet for this value will insure that the peak velocity on the profile is always equal to or greater than 1.5 feet (at very close positions to the rotor, the ROTWASH methodology often calculates an unrealistically thin boundary layer if a minimum limit is not specified). Each of the four parameters is input by typing the appropriate code, <RETURN>, the new input data value, and <RETURN> to end the sequence. The last parameter on the menu is the filename for data that is written to disk if the graphics file toggle switch is set to <Y>.

The wall jet velocity profile, calculated by the program using default inputs, is presented in figure D-11 when the <RETURN> key is typed by itself. Output from the analysis describes the shape of both the mean and peak velocity profiles; an example is presented in figure D-12 correlated with Bell XV-15 flight test data (this particular example correlates to a rotor height of 37.5 feet and a DFAC value of 66.1 feet on figure D-10).

The output format provides velocity profile data in units of either feet per second, knots, or pounds per square foot (also referred to as dynamic pressure).

If the specified increment in vertical height is small or the maximum calculated height is large, the quantity of data to be output to the screen may exceed the 10-line limit for 1 screen frame. When this situation occurs, the typing of <C> at the

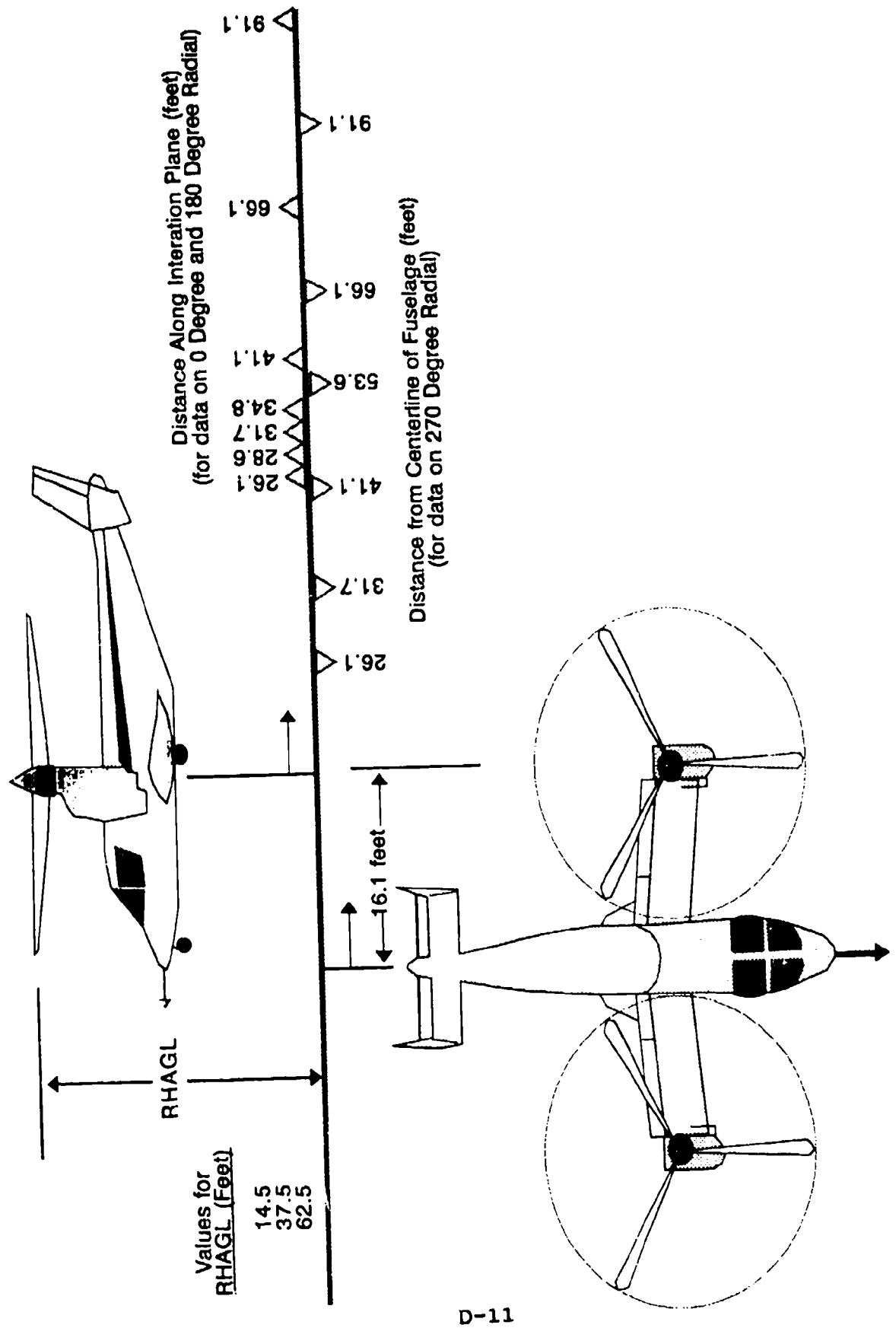


FIGURE D-10 XV-15 FLIGHT TEST DATA MEASUREMENT LOCATIONS

## SINGLE ROTOR VELOCITY PROFILE AT RADIUS = 50.0 FT

PROFILE BOUNDARY HEIGHT = 11.49 FT  
 HALF-VEL.HEIGHT = 4.10 FT  
 MAX-VEL HEIGHT = 1.15 FT

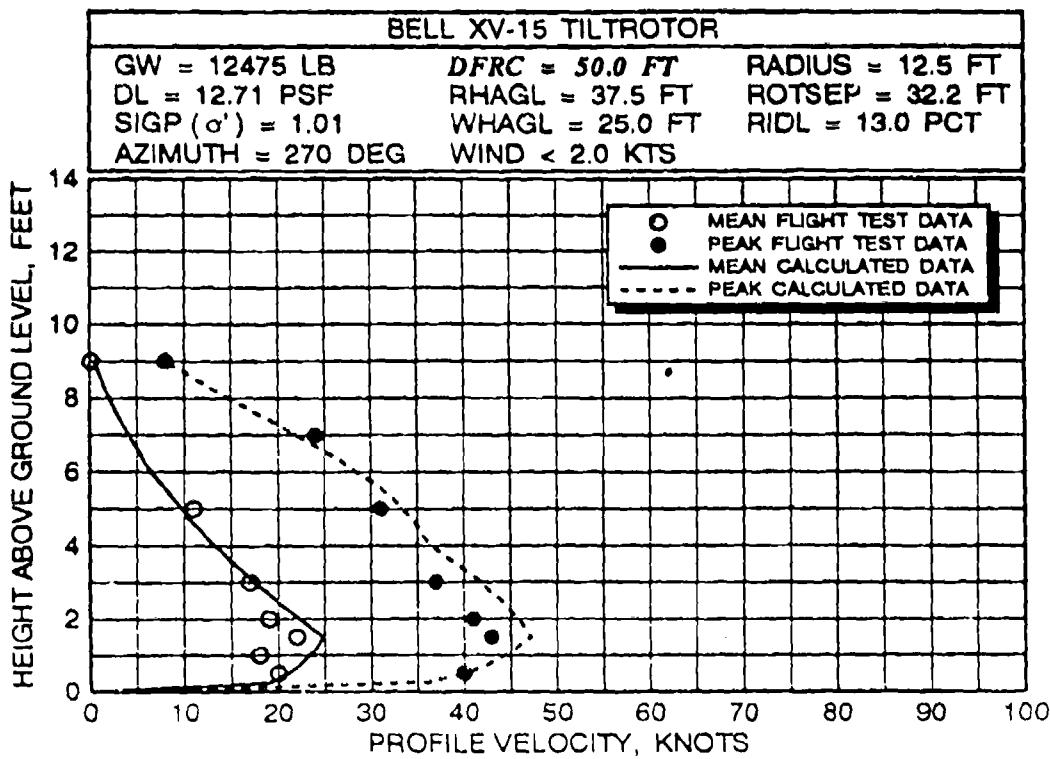
HEIGHT (FT)	MEAN VELOCITY (FPS)	MEAN VELOCITY (KN)	PEAK VELOCITY (FPS)	PEAK VELOCITY (KN)	MEAN Q (PSF)	PEAK Q (PSF)
.00	.000	.000	.000	.000	.000	.000
1.00	42.306	25.077	78.945	46.796	2.127	7.407
2.00	40.282	23.878	81.231	48.151	1.928	7.842
3.00	32.043	18.994	74.263	44.021	1.220	6.554
4.00	24.823	14.714	65.002	38.531	.732	5.021
5.00	18.565	11.005	59.944	35.533	.410	4.270
6.00	13.240	7.848	51.299	30.408	.208	3.128
7.00	8.829	5.233	39.909	23.657	.093	1.893
8.00	5.319	3.153	27.477	16.288	.034	.897
9.00	2.700	1.600	15.691	9.301	.009	.293
10.00	.964	.571	6.222	3.688	.001	.045

TYPE &lt;C&gt;ONTINUE, NEXT &lt;P&gt;OINT, &lt;N&gt;EW CASE, E&lt;X&gt;IT ==&gt;

FIGURE D-11 WALL JET VELOCITY PROFILE OUTPUT FORMAT

prompt (at the bottom of the screen) results in the next 10 lines of data being written to the screen. If the code value <P> is typed, the program returns to the wall jet analysis menu. The typing of code <N> results in the program returning to the master input data menu. If the code <X> is typed, the program returns to the DOS system prompt.

Flight test data, correlated with output from the wall jet option, are presented in section 3 of Volume I of this report for the Bell XV-15, Bell-Boeing MV-22, Sikorsky CH-53E, Sikorsky SH-60B, and Canadair CL-84. Based on the correlation conducted for references D-1 and D-2, it is generally recommended that the wall jet option be used for calculation of velocity profiles at distances greater than 1.5 times the rotor radius from the center of the rotor. At distances less than this value, the mathematical model is not detailed enough to predict rotorwash flowfield characteristics accurately. This limitation is not serious because distances closer to the rotor tip than 1.5 times the rotor radius have little practical reason for being analyzed for rotorwash effects on the environment. Collision avoidance with respect to objects in close proximity to the rotorcraft is the critical issue at this close a distance.



**FIGURE D-12 XV-15 VELOCITY PROFILE CORRELATION**

#### D.1.5 THE TWIN-ROTOR INTERACTION PLANE OPTION

The twin-rotor interaction plane option calculates the velocity profile contained in the plane which is oriented perpendicular to the ground and to the line segment which connects the center of both rotor hubs (refer to figure D-1). After choosing the interaction plane option on the velocity analysis option menu, the user must specify the same parameters on the velocity profile status menu that are required with the wall jet option. The only difference between the parameters is the reference position for specification of the horizontal location of the velocity profile with respect to the rotor (the first menu option). For the interaction plane analysis, this distance is referenced as 0 at the intersection of the interaction plane and the line connecting the rotors and not directly to the center of one of the two rotors (i.e., the input value for distance along the interaction plane (DAIP) for a tiltrotor is along a line that is an extension of the fuselage centerline as seen in figure D-10). No velocity profile differences are assumed to exist by the mathematical model for points equidistant along the interaction plane but on opposite sides of the line connecting the rotors. For a tiltrotor, this means that the calculated velocity profiles both

directly in front of and directly aft of the aircraft are the same when equidistant along the interaction plane.

Example output from the interaction plane option is presented in figure D-13. This data format closely resembles that of the wall jet option except that both horizontal and vertical velocity profile components are calculated. The horizontal velocity component is identified by the "H" in the column following the height column and the vertical component by the "V". The mechanics for viewing data on the screen (if more data exist than will fit on one screen frame) and for transferring to other menus are exactly as are described for the wall jet option.

TWIN ROTOR INTERACTION PLANE VELOCITY PROFILE AT STATION = 50.0 FT							
HEIGHT (FT)		MEAN VELOCITY (FPS)		PEAK VELOCITY (FPS)		MEAN Q (PSF)	PEAK Q (PSF)
.00	H	.000	.000	.000	.000	.000	.000
	V	.000	.000	.000	.000	.000	.000
1.00	H	63.626	37.715	103.992	61.643	4.811	12.852
	V	21.760	12.899	35.555	21.082	.563	1.503
2.0	H	66.665	39.517	108.960	64.538	5.282	14.110
	V	24.133	14.305	39.443	23.381	.692	1.849
3.00	H	65.800	39.004	107.545	63.749	5.146	13.746
	V	25.136	14.900	41.082	24.352	.751	2.006
4.00	H	64.912	38.478	106.093	62.889	5.008	13.377
	V	26.094	15.468	42.649	25.281	.809	2.162

TYPE <C>ONTINUE, NEXT <P>POINT, <N>EW CASE, E<X>IT ==>

FIGURE D-13 INTERACTION PLANE VELOCITY PROFILE OUTPUT FORMAT

Output from the interaction plane option, correlated with XV-15 flight test data, is presented in figure D-14 as an example. These data are excerpted from reference D-2. Other original flight test data for both the Bell XV-15, Bell-Boeing MV-22, and Canadair CL-84 (tiltwing) are documented in section 3 of Volume I of this report.

Several practical recommendations need to be noted for users of the interaction plane option. When analyzing tiltrotor and tiltwing configurations, the user must be careful to avoid choosing analysis locations that are coincident with components of the nose or tail structure on the aircraft. Also, locations in close proximity to the nose or tail of a real aircraft should not be expected to have rotorwash flowfield characteristics identical to calculated velocity profiles. At these locations unmodeled airframe aerodynamic interferences significantly influence the rotorwash flowfield structure. Flight test data

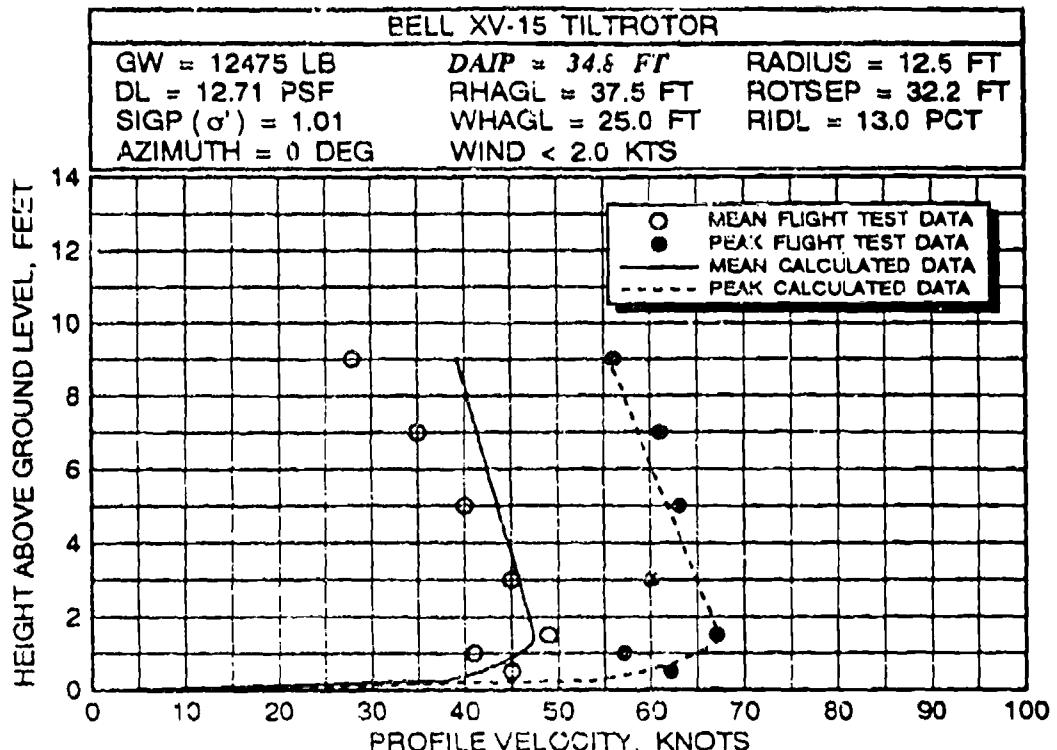


FIGURE D-14 XV-15 INTERACTION PLANE VELOCITY PROFILE CORRELATION

obtained from the XV-15, MV-22, and CL-84 indicate that measured mean and peak velocity profiles at points equidistant along the interaction plane (both in front of and aft of an actual aircraft) often do not yield identical results as might be expected. Therefore, output from this analysis option should be calibrated with flight test data whenever possible in an attempt to determine whether positions forward or aft of the aircraft may be more critical for analysis.

#### D.1.6 GROUND VORTEX ANALYSIS OPTION

A ground vortex structure is formed when ambient wind and/or rotorcraft translational velocity overcome the rotor-induced wall jet flowfield. A diagram of the ground vortex is presented in figure D-15. Due to the elementary nature of the mathematical model formulation used in the ROTWASH program, the ground vortex option should be used with caution. As discussed in section 2 of Volume I of this report, almost no test data exist to validate the mathematical model. Also, the single main rotor helicopter is the only configuration that can be analyzed with the model as presently formulated. Since all examples presented up to this point in the user's guide have been for the XV-15, it is necessary to define input data for a single main rotor helicopter

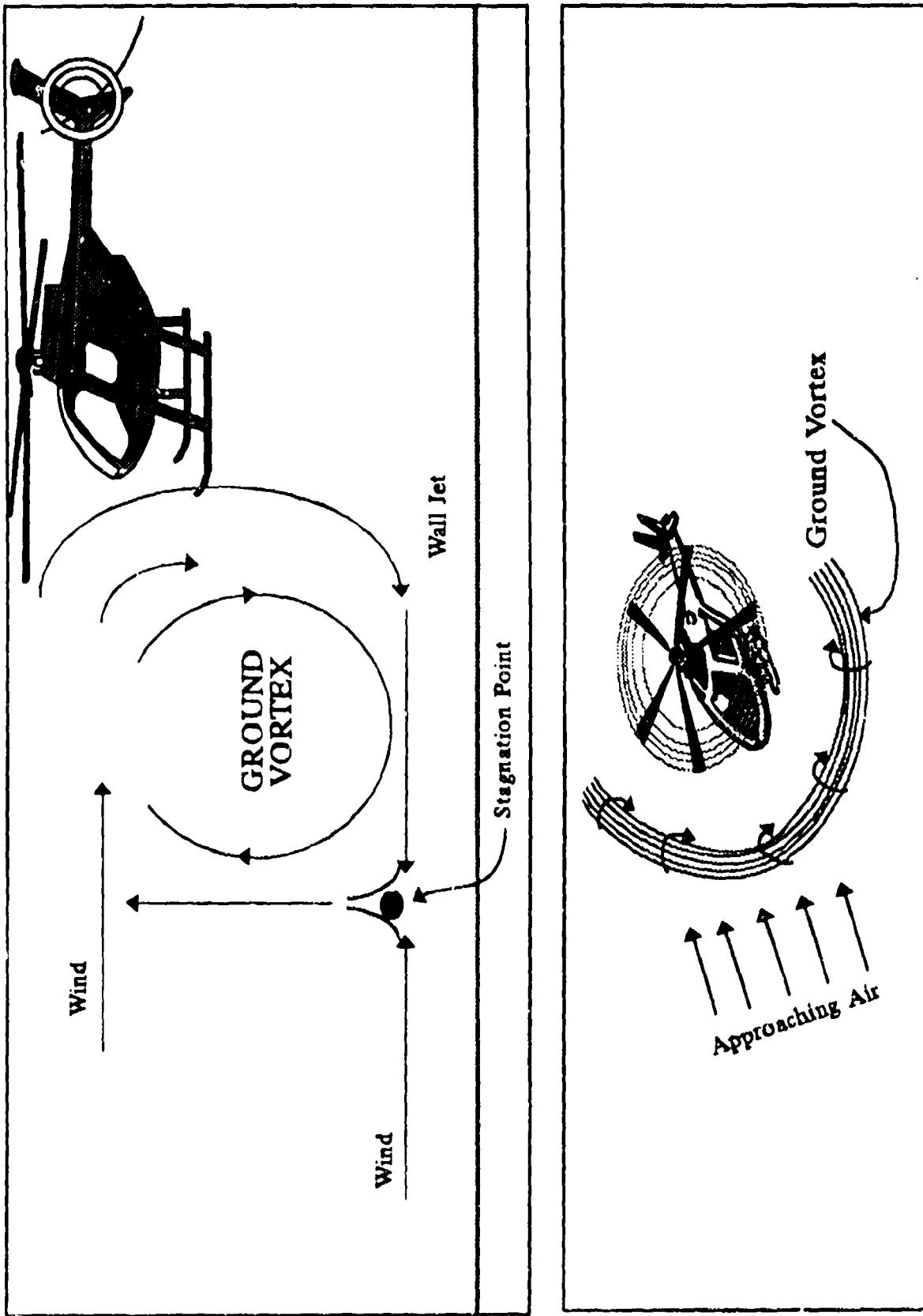


FIGURE D-15 GROUND VORTEX STRUCTURAL CHARACTERISTICS

ROTWASH USER INPUT DATA MENU			
CODE	PARAMETER	VALUE	UNITS
A	NUMBER OF ROTORS (1 OR 2)	1	-ND-
B	HUB TO HUB ROTOR SEPARATION	.0	FT
C	ROTOR RADIUS	39.5	FT
D	GROSS WEIGHT	56000.0	LB
E	FUSELAGE DOWNLOAD FACTOR	5.0	PCT
F	ROTOR HEIGHT ABOVE GROUND	30.0	FT
G	SHAFT TILT ANGLE (<20 DEG)	.0	DEG
H	AIR DENSITY RATIO	1.0000	ND
I	AMBIENT WIND (-10 TO 10 KT)	.0	KT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

**FIGURE D-16 CH-53E INPUT DATA FOR THE GROUND VORTEX EXAMPLE**

before the ground vortex option is explained in detail. The Sikorsky CH-53E configuration has been chosen for this task. The main input data menu for this configuration, as typed into the program, is presented in figure D-16.

The ground vortex analysis option is specified by selection of the character <G> on the velocity analysis option menu as shown in figure D-5. The user is then required to complete the ground/disk vortex input data menu which is presented in figure D-17. Two of the parameters specified on this menu are rotorcraft configuration parameters. These parameters are the rotor tip speed (feet/second) and the number of rotor blades. The next parameter to be specified is the rotorcraft translational velocity with respect to the surrounding air mass (i.e., an input of 15 knots can be either 15 knots ground speed on a no-wind day or 0 knots ground speed on a day with a 15-knot headwind). Each of these values is input with the keyboard using the same techniques that have been previously discussed.

The next four menu parameters define the position in three-dimensional space (feet) where the velocity profile will be calculated (see figure D-18). The positive directions for the coordinate system are aft and right from the center of the rotor. Therefore, in order to calculate a slice of the ground vortex directly in front of the rotor, a negative X-value (longitudinal position) is input along with a zero Y-value (lateral position). The Z-axis increment (feet) and maximum calculation height (feet) parameters define the number of points that are calculated between ground level and the maximum height of interest.

GROUND/DISK VORTEX INPUT DATA MENU  
(FOR SINGLE MAIN ROTOR HELICOPTERS ONLY)

CODE	PARAMETER	VALUE	UNITS
A	ROTOR TIP SPEED	733.00	FPS
B	NUMBER OF ROTOR BLADES	7.00	-ND-
C	TRANSLATIONAL SPEED	16.00	KTS
D	XT POSITION	-60.00	FT
E	YT POSITION	.00	FT
F	ZT CALCULATION INCREMENT	2.00	FT
G	MAXIMUM CALCULATION HEIGHT	20.00	FT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

**FIGURE D-17 GROUND/DISK VORTEX INPUT DATA MENU**

After each input data parameter has been specified, the user types the <RETURN> key to initiate the analysis. The response of the program is to list three calculated parameters which are followed by a prompt. An example of this response is provided in figure D-19. The calculated values are the nondimensionalized rotor height above ground and two advance ratio parameters. The program prompt following the screen output requires the user to input the ground vortex strength ratio which is obtained from the graph in figure D-20 using the three calculated parameters. Background on the use of this figure is discussed in section 2 of Volume I of this report. The limits presented on the graph in figure D-20 define the advance ratio range wherein the ground vortex would be expected to occur. At advance ratios much less than 0.035, the ground vortex does not have favorable conditions for formation. At advance ratios slightly greater than 0.055, the ground vortex is dispersed by the rotor because the translational velocity relative to the air mass is too high for the vortex to maintain position. After the user has entered the ground vortex strength ratio, the program calculates the ground vortex circulation and the position of the ground vortex core with respect to the axis system presented in figure D-18. This output is also presented in figure D-19 below the prompt for the ground vortex strength ratio.

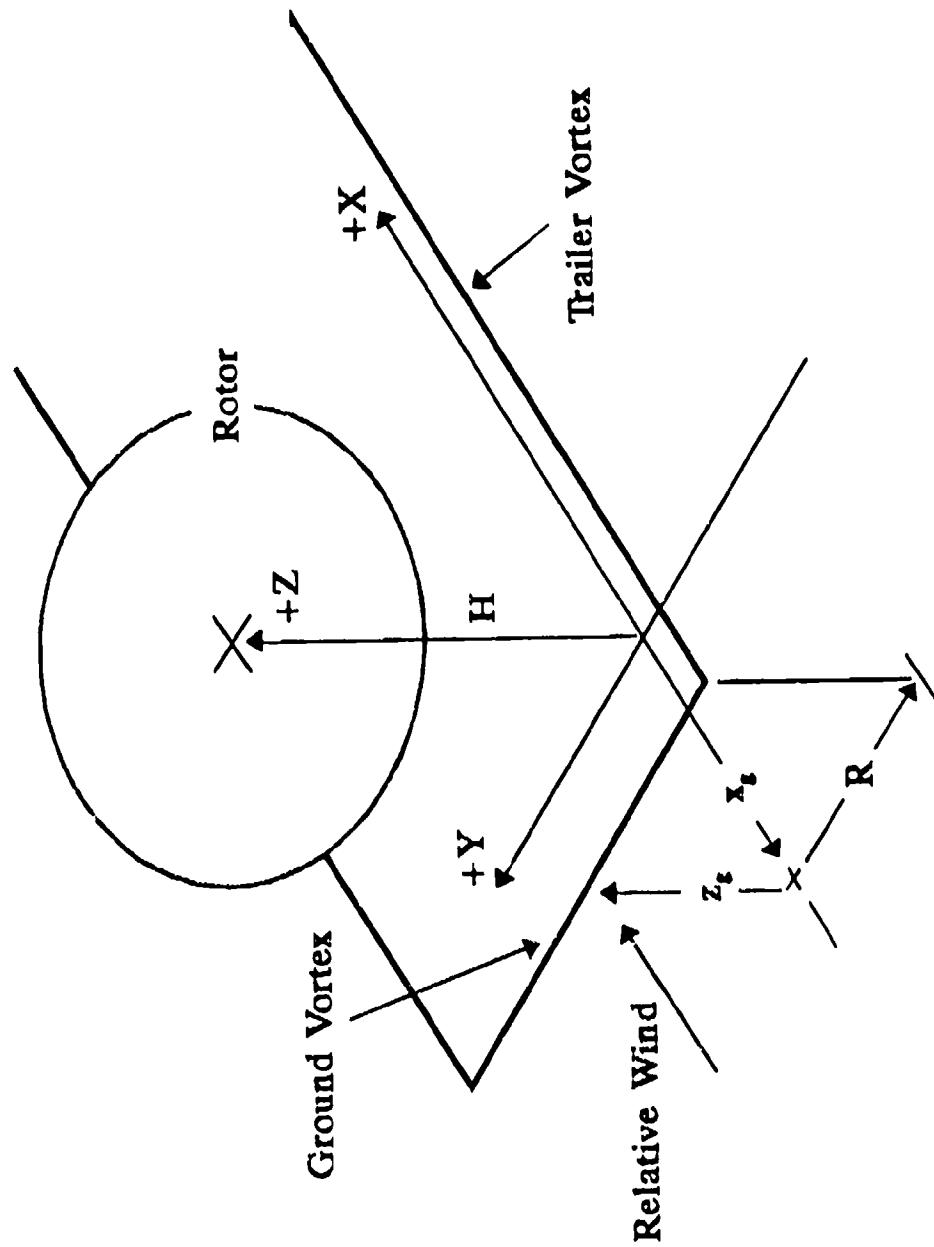


FIGURE D-18 HORSESHOE VORTEX GEOMETRY FOR CALCULATION OF GROUND VORTEX HAZARD POTENTIAL.

ROTOR HEIGHT ABOVE GROUND H/D	.3797
ADVANCE RATIO MU-STAR	.5373
ADVANCE RATIO MU	.0368

ENTER GROUND VORTEX STRENGTH RATIO  
(SEE FIGURE D-20)                            ==> 3.

GROUND VORTEX CORE POSITION

X-LOCATION (XXGV)                            =        -59.14    FT  
Y-LOCATION (ZZGV)                            =        9.15    FT

GROUND VORTEX CIRCULATION =        732.35    FT\*\*2/SEC

PRESS <RETURN> TO CONTINUE

**FIGURE D-19 GROUND VORTEX ANALYSIS INTERMEDIATE OUTPUT**

Engineering data from the ground vortex analysis option is obtained by typing the <RETURN> key after the vortex position parameters are displayed. An example of the output format is presented in figure D-21. Calculated field velocities at the various points along the profile Z-axis are presented in both a vectorial XYZ component format and as a total resolved magnitude in units of feet per second and knots. These same data are also provided to the user as dynamic pressures in units of pounds per square feet.

#### D.1.7 DISK EDGE VORTEX ANALYSIS OPTION

The disk edge vortex analysis option was developed to provide a capability to estimate the strength of trailing vortices behind helicopters in forward flight as described by figure D-22. Like the ground vortex option, this option is limited to use with the single main rotor helicopter configuration. Approximations of vortex core size are not calculated by the mathematical model and must be estimated using flight test data. Available flight test data are presented in section 3.6 of Volume I of this report. All examples presented in the user's guide for this analysis option utilize the same CH-53E input data array that was described previously.

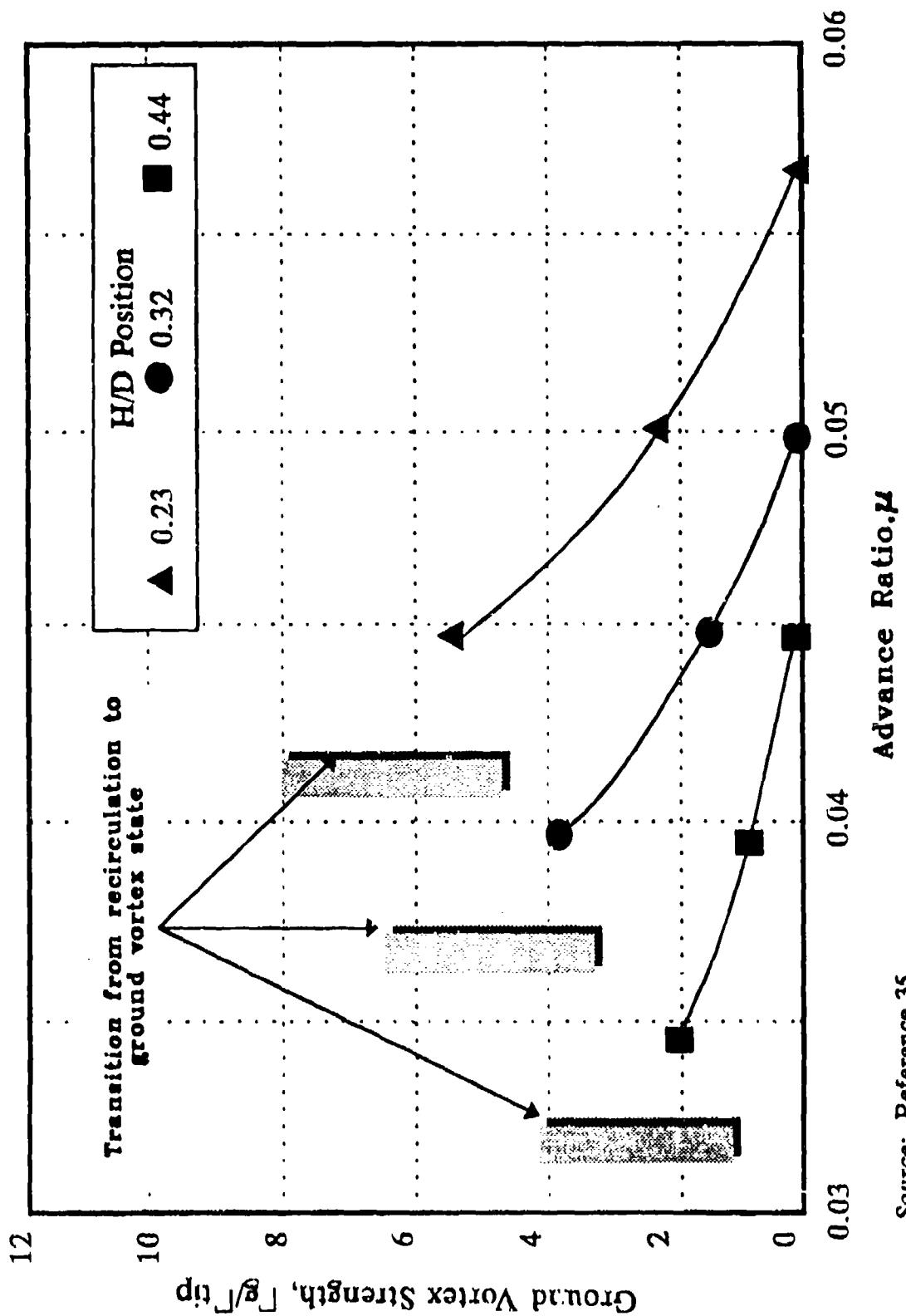


FIGURE D-20 CALCULATED GROUND VORTEX CIRCULATION STRENGTH

Source: Reference 35.

HEIGHT (FT)	MEAN VELOCITY			MEA'. Q (PSF)
	(FPS)	(KN)		
.00	X -24.582	-14.572	.718	
	Y .000	.000	.000	
	Z .000	.000	.000	
	T 24.582	14.572	.718	
2.00	X -25.790	-15.288	.790	
	Y .000	.000	.000	
	Z 1.013	.601	.001	
	T 25.810	15.299	.792	
4.00	X -30.173	-17.886	1.082	
	Y .000	.000	.000	
	Z 2.868	1.700	.010	
	T 30.309	17.966	1.092	

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

**FIGURE D-21 GROUND VORTEX VELOCITY FIELD OUTPUT DATA**

Execution of the disk edge vortex option is initiated by choosing <D> on the velocity analysis option menu shown in figure D-5. The ground/disk vortex input data menu, shown in figure D-17, must then be completed as described in the previous section. All sign conventions used in the specification of locations for the calculation of field velocities are the same as for the ground vortex option. After the input data menu is completed, the analysis option is executed by typing the <RETURN> key.

The initial program response, figure D-23, is to write to the screen the calculated values for the vortex circulation and the settling angle of the trailing vortex components as defined in figure D-22 for a forward-flight velocity of 50 knots and a rotor height above ground of 100 feet. When executing this option, it is important that the user confirm that the calculated settling angle is less than approximately 20 degrees. At settling angles larger than this value, the airspeed of the helicopter is probably too slow to sustain the formation of the trailing edge vortex system which is predicted using this mathematical model, and results should be considered suspect. User specified velocity field calculations are presented after the <RETURN> key is typed in the same format as was discussed with the ground vortex option. An example output for the CH-53E is presented in figure D-24.

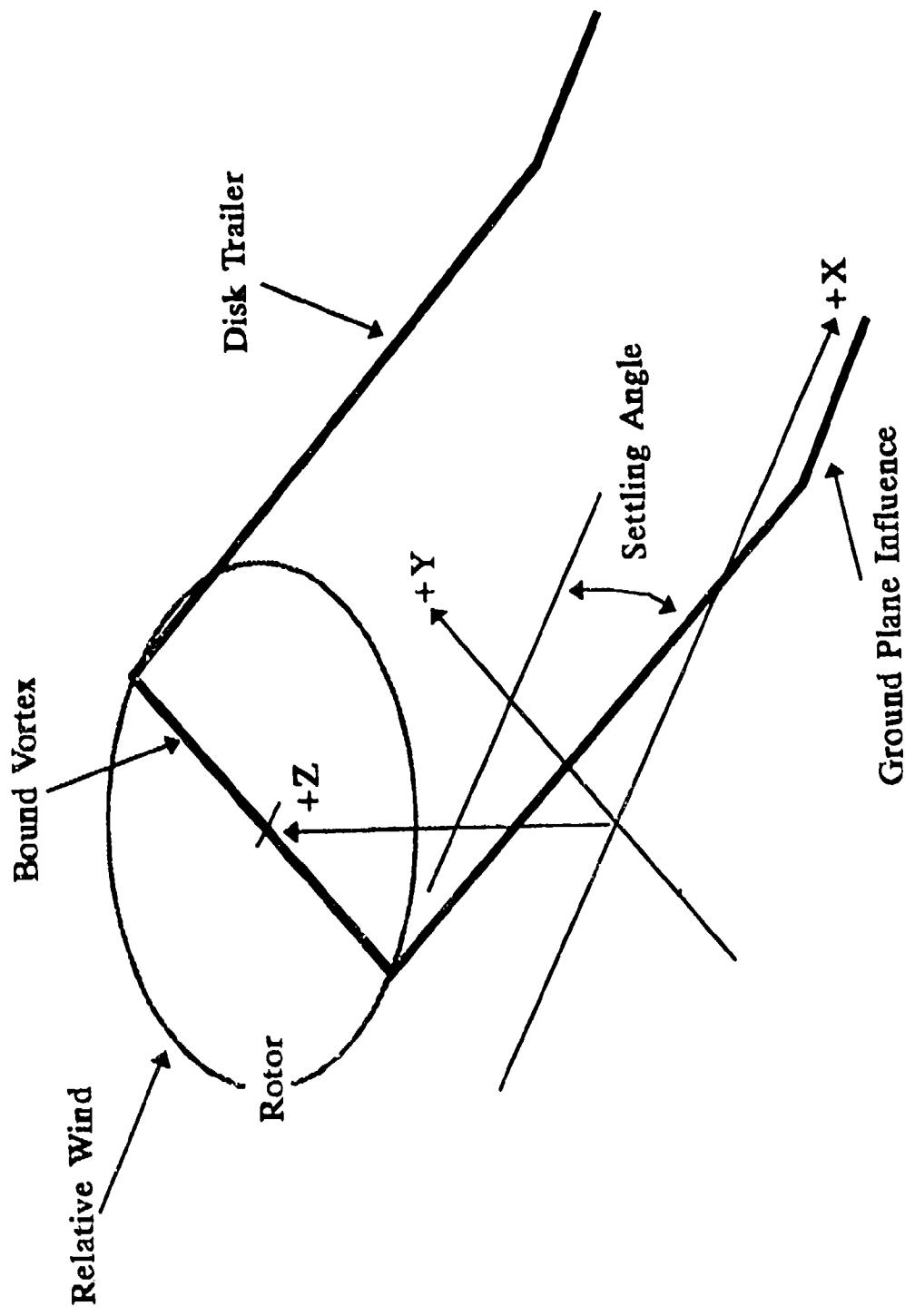


FIGURE D-22 HORSESHOE VORTEX GEOMETRY FOR CALCULATION OF FORWARD FLIGHT WAKE HAZARD POTENTIAL

Other features of the mathematical model which should be noted are described below.

1. The calculated trailing vortex strength does not decay as a function of increasing distance from the helicopter or with increasing time. This weakness in the model will affect correlation with flight test data and could result in predicted values that are greater than measured values for field velocities.
2. The decay of the trailing vortex structure after impingement with the ground is not modeled. Any prediction of field velocities behind the initial impingement point should not be considered valid. The location of the impingement point with respect to the ground and the location of points specified for velocity field calculations must be checked by hand calculation to ensure that geometry constraints are not violated. This is accomplished by using the rotor height and the settling angle to calculate the horizontal distance behind the helicopter where the impingement occurs.

#### D.1.8 PERSONNEL OVERTURNING FORCE AND MOMENT ANALYSIS

The personnel overturning force and moment analysis model is formulated for use with both the single main rotor and twin-rotor configurations. The initial task of the model is to calculate the velocity profile for a specified location. The calculated velocity profile is then integrated over the projected area of a human body to obtain estimates of the applied aerodynamic force and moment. This analysis technique is summarized in figure D-25.

Use of the overturning force and moment option is initiated by choosing <H> (for hazard) on the program logic/comment menu. This is followed by the choice of <M> (for overturning force/moment) on the hazard analysis option menu as shown in figure D-6. The user then specifies the parameters listed on the overturning force and moment data menu presented in figure D-26. The first parameter on this menu specifies the use of either the wall jet or the interaction plane analysis for creation of velocity profile data. The second option specifies the use of either the "large" (6 feet in height) or "small" (4 feet in height) human body mathematical model. The third parameter provides the user the capability to specify a graphics output filename (assuming this option has been toggled ON using the program logic/comment menu). If the user executes the option without changing the filename and a file already exists with the same filename, the user is notified and required to change the filename. Three of the last four menu variables define the locations that are to be analyzed using the option. These variables, all in units of feet, are the initial station position for analysis, the increment in station position, and the final

DISK VORTEX VELOCITY PROFILE DATA

X-LOCATION (XT)	=	150.00	FT
Y-LOCATION (YT)	=	.00	FT
VORTEX CIRCULATION	=	5441.24	FT**2/SEC
VORTEX CIRCULATION	=	505.51	M**2/SEC
5-M INITIAL CIRCULATION	=	232.37	M**2/SEC
SETTLING ANGLE	=	9.29	DEG

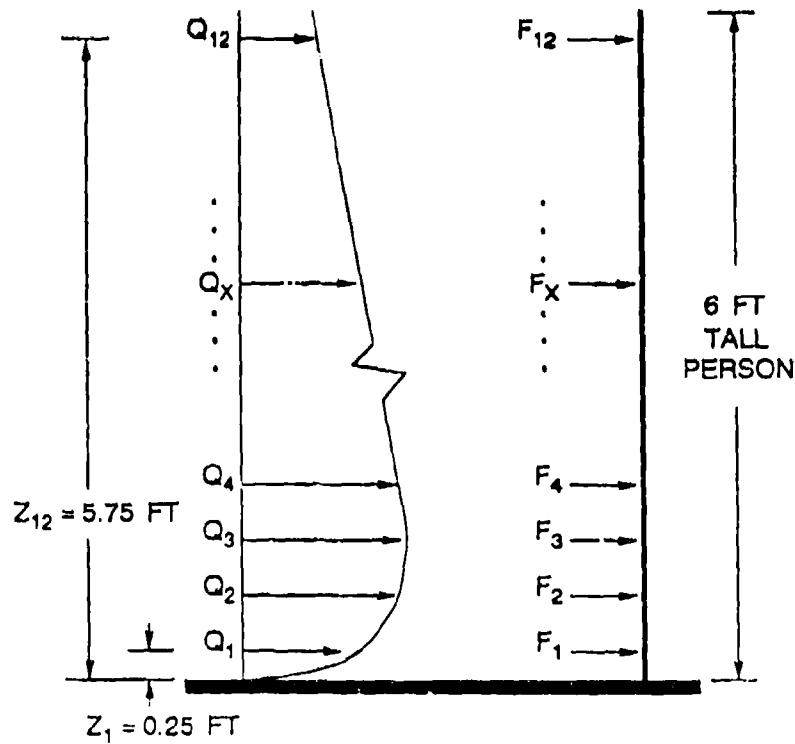
PRESS <RETURN> TO CONTINUE

FIGURE D-23 DISK EDGE VORTEX OPTION INTERMEDIATE OUTPUT

HEIGHT (FT)	MEAN VELOCITY		MEAN Q
	(FPS)	(KN)	(PSF)
.00	X -4.052	-2.402	.020
	Y .000	.000	.000
	Z .000	.000	.000
	T 4.052	2.402	.020
50.00	X -6.444	-3.820	.049
	Y .000	.000	.000
	Z -27.295	-16.180	.885
	T 28.046	16.625	.935
100.00	X -5.735	-3.399	.039
	Y .000	.000	.000
	Z -30.049	-17.812	1.073
	T 30.592	18.134	1.112

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

FIGURE D-24 VELOCITY FIELD OUTPUT DATA FROM THE DISK EDGE VORTEX OPTION



**FIGURE D-25 OVERTURNING FORCE AND MOMENT CALCULATION PROCEDURES**

station position, respectively. The fourth parameter is the user option to specify a minimum boundary layer height (discussed in section D.1.4 of the user's guide). The mechanics for input of the desired values using this menu are as described for previous menus.

After the analysis is executed by typing the <RETURN> key, the calculated results are written out in the format presented in figure D-27. Three columns of data are written using this format. The first column identifies either the distance from rotor center (DFRC), for the wall jet option or the distance along the interaction plane (DAIP) for the interaction plane option.

The second and third columns are the associated total force and total moment values calculated for the projected area of a human body. Example data for the XV-15 using this option are presented in figure D-28 for reference. At the bottom of the screen, the user is required to return to the previous menu by typing <P>,

**OVERTURNING FORCE/MOMENT DATA MENU**

CODE	PARAMETER	VALUE	UNITS
A	<W>ALL JET CR <I>NTERACTION PLANE	W	
B	<L>ARGE OR <S>MALL PERSON	L	
C	DATA OUTPUT FILENAME	OTDFRC.PTS	
D	INITIAL STATION POSITION	50.00	FT
E	HORIZONTAL INCREMENT	10.00	FT
F	MAXIMUM STATION POSITION	100.00	FT
G	MINIMUM BOUNDARY LAYER HEIGHT	1.50	FT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

**FIGURE D-26 OVERTURNING FORCE AND MOMENT DATA MENU**

**SUMMARY OF OVERTURNING FORCES AND MOMENTS**

RADIUS (FT)	TOTF (LB)	TOTM (FT-LB)
50.00	42.721	114.596
60.00	33.708	91.718
70.00	25.046	69.346
80.00	17.520	49.892
90.00	11.511	33.382
100.00	6.926	20.269

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

**FIGURE D-27 SIMPLIFIED OUTPUT FORMAT FOR THE OVERTURNING FORCE AND MOMENT ANALYSIS**

the master input data menu by typing <N>, or to exit the program by typing <X>. By typing <C>, the user can view the next video screen of data if more than one screen of data is generated. Otherwise, the <C> option works identically to the <P> option.

The user can examine the detailed calculations used to create the summary output by specifying the desired analysis location as the initial station position. This input must then be followed by specification of the increment value as 0.0 or only the summary output will appear (as shown in figure D-29). The resulting "large" person output using this option is presented on two screen frames as shown in figure D-30. The first output frame presents a summary of the velocity profile calculations as a function of height above ground at the specified station position. The second output frame presents the associated calculations for dynamic pressure, overturning force, and overturning moment. The last two columns in the second table are values of total force and moment summed for the incremental increase in height.

In this example, the force and moment values of 42.7 pounds and 114.6 foot-pounds, respectively, at 5.75 feet are the total force and moment values that would normally be printed out in the summary output (figure D-27). These values are checked by totaling the individual height-related values in the overturning force and moment columns (second and third columns). An example output for the second screen of the "small" person option is presented in figure D-31 for reference.

Both qualitative and quantitative overturning force and moment data are presented in section 5 of volume I of this report correlated with ROTWASH program output for the Bell XV-15, Sikorsky CH-53E, and the Sikorsky S-61. These calculated data all assume a coefficient of drag for a human body of 1.1 (which according to Hoerner, reference D-6, can vary from 1.0 to approximately 1.3).

#### D.1.9 PARTICULATE CLOUD ANALYSIS OPTION

The methodology used in the calculation of particulate cloud size is presented in section 5.8 of volume I of this report along with a very limited amount of flight test data. This option is applicable to both single main rotor and twin-rotor configurations. The particulate cloud geometry utilized in the analysis option is presented in figure D-32.

The particulate clcud option is initiated with the typing of <C> on the hazard analysis option menu as shown in figure D-6. The screen that is written subsequently presents the user with a prompt for input of the terrain erosion factor. The value for this factor is chosen from the graph in figure D-33.

ROTOR HEIGHT,  
FEET

XV-15  
FLIGHT TEST DATA

XV-15  
CALCULATED DATA

37.5

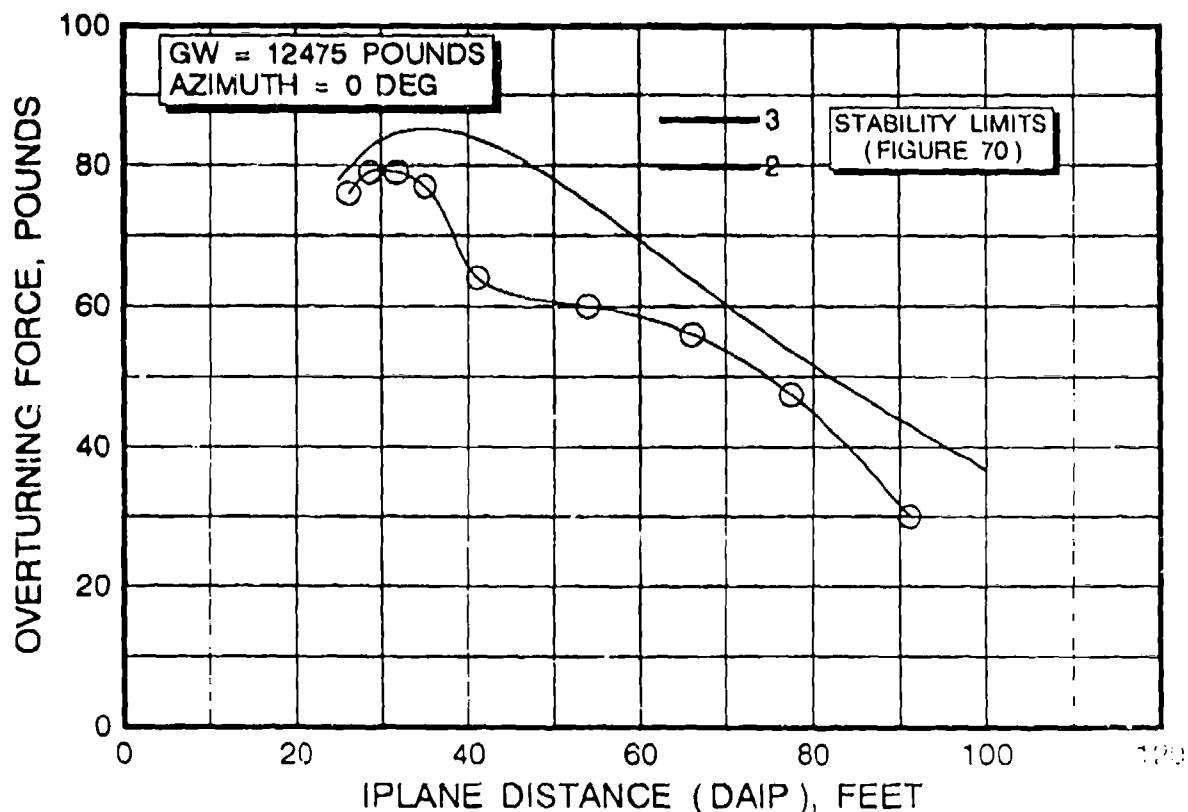
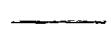


FIGURE D-28 BELL XV-15 OVERTURNING FORCE AS A FUNCTION OF DISTANCE ALONG THE INTERACTION PLANE (0 DEGREE AZIMUTH)

OVERTURNING FORCE/MOMENT DATA MENU

CODE	PARAMETER	VALUE	UNITS
A	<W>ALL JET OR <I>NTERACTION PLANE	W	
B	<L>ARGE OR <S>MALL PERSON	L	
C	DATA OUTPUT FILENAME	OTDFRC.PTS	
D	INITIAL STATION POSITION	50.00	FT
E	HORIZONTAL INCREMENT	.00	FT
F	MAXIMUM STATION POSITION	100.00	FT
G	MINIMUM BOUNDARY LAYER HEIGHT	1.50	FT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

FIGURE D-29 MENU SPECIFICATION OF DETAILED FORCE/MOMENT OUTPUT

SINGLE ROTOR VELOCITY PROFILE AT RADIUS = 50.0 FT

HEIGHT (FT)	MEAN VELOCITY (FPS)	MEAN VELOCITY (KN)	PEAK VELOCITY (FPS)	PEAK VELOCITY (KN)	MEAN Q (PSF)	PEAK Q (PSF)
.25	34.705	20.572	64.762	38.389	1.431	4.984
.75	40.602	24.068	75.767	44.912	1.959	6.822
1.25	43.676	25.890	81.502	48.312	2.267	7.894
1.75	42.515	25.202	82.535	48.924	2.148	8.096
2.25	38.121	22.597	79.742	47.269	1.727	7.557
2.75	34.004	20.157	76.248	45.197	1.374	6.909
3.25	30.146	17.870	72.134	42.759	1.080	6.184
3.75	26.537	15.730	67.491	40.007	.837	5.413
4.25	23.170	13.734	63.591	37.695	.638	4.806
4.75	20.041	11.880	61.475	36.441	.477	4.491
5.25	17.147	10.164	58.134	34.460	.349	4.016
5.75	14.485	8.586	53.785	31.882	.249	3.438

TYPE <RETURN> TO CONTINUE

SINGLE ROTOR FORCE PROFILE AT RADIUS = 50.0 FT

HEIGHT (FT)	PEAK Q (PSF)	FOVER (LB)	OVERM (FT-LB)	TOT F (LB)	TOT M (FT-LB)
.25	4.984	3.016	.754	3.016	.754
.75	6.822	4.128	3.096	7.143	3.850
1.25	7.894	4.776	5.970	11.919	9.820
1.75	8.096	4.898	8.571	16.817	18.391
2.25	7.557	4.572	10.287	21.389	28.678
2.75	6.909	4.180	11.495	25.569	40.174
3.25	6.184	3.741	12.159	29.311	52.333
3.75	5.413	3.275	12.282	32.586	64.615
4.25	4.806	2.908	12.357	35.493	76.972
4.75	4.491	2.717	12.907	38.211	89.879
5.25	4.016	2.430	12.757	40.641	102.636
5.75	3.438	2.080	11.960	42.721	114.596

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

FIGURE D-30 DETAILED OUTPUT FORMAT FOR THE "LARGE" PERSON ANALYSIS OPTION

SINGLE ROTOR FORCE PROFILE AT RADIUS = 50.0 FT

HEIGHT (FT)	PEAK Q (PSF)	FOVER (LB)	OVERM (FT-LB)	TOT F (LB)	TOT M (FT-LB)
.25	4.984	1.919	.480	1.919	.480
.75	6.822	2.627	1.970	4.546	2.450
1.25	7.894	3.039	3.799	7.585	6.249
1.75	8.096	3.117	5.455	10.702	11.703
2.25	7.557	2.909	6.546	13.611	18.250
2.75	6.909	2.660	7.315	16.271	25.565
3.25	6.184	2.381	7.738	18.652	33.303
3.75	5.413	2.084	7.816	20.736	41.118

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

FIGURE D-31 DETAILED OUTPUT FORMAT FOR THE SECOND SCREEN FRAME OF THE "SMALL" PERSON ANALYSIS OPTION

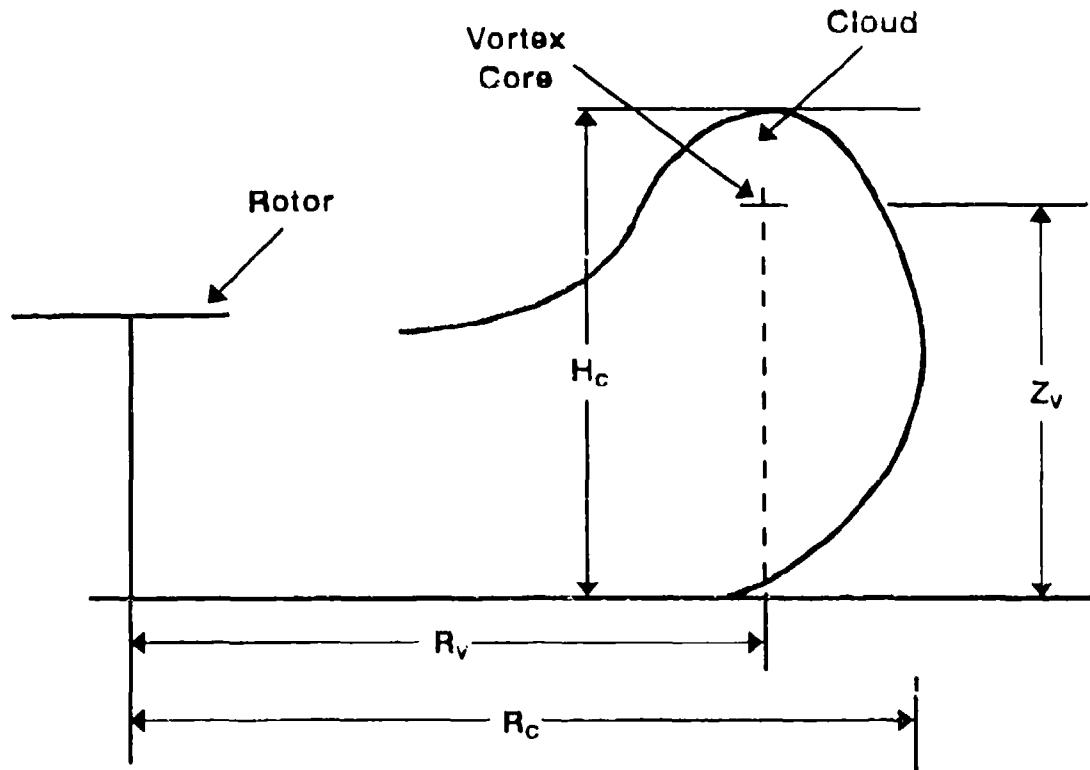


FIGURE D-32 PARTICULATE CLOUD ANALYSIS GEOMETRY DEFINITION

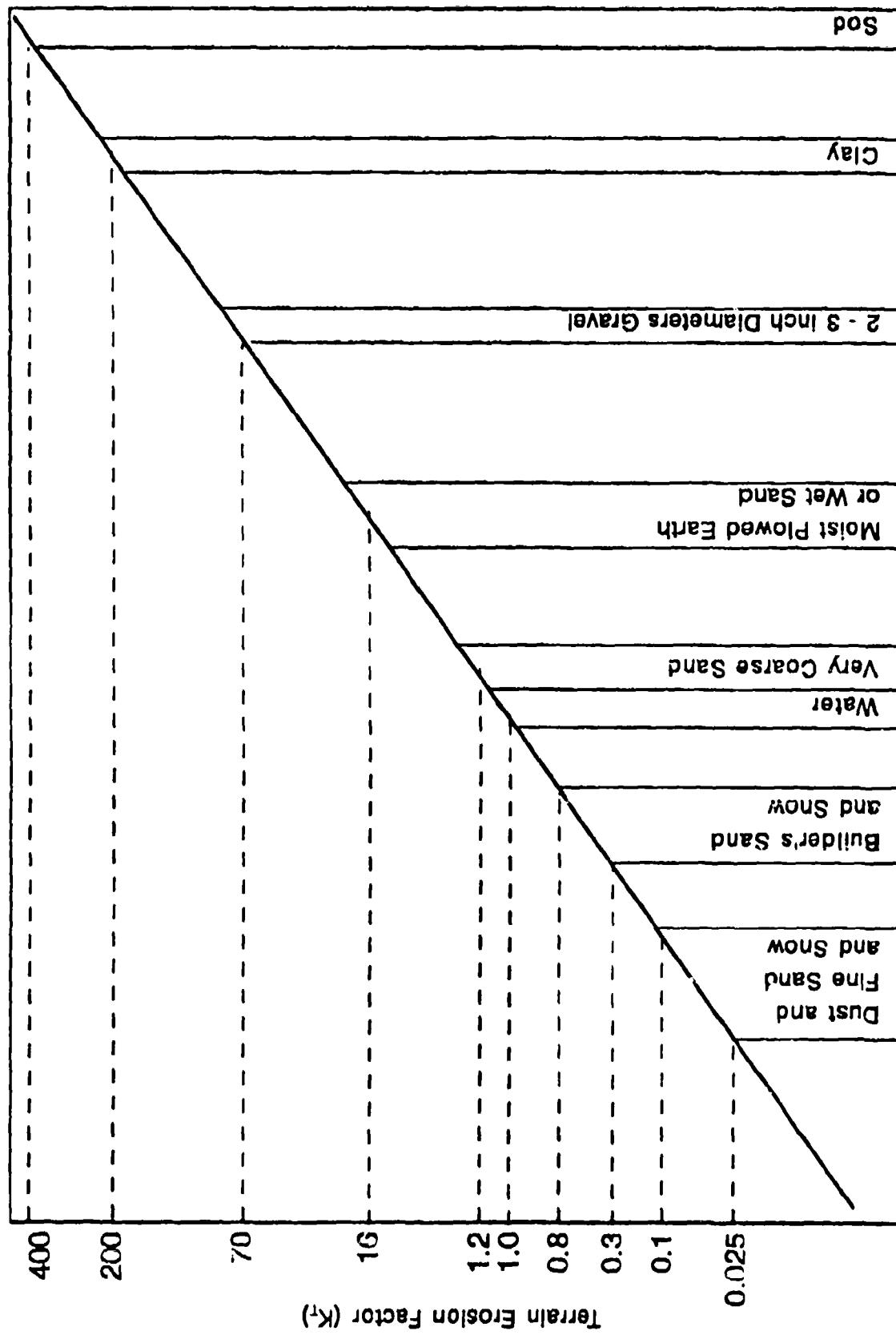


FIGURE D-33 APPROXIMATE VALUES FOR THE TERRAIN EROSION FACTOR ( $K_t$ ) AS IDENTIFIED IN THE LITERATURE

The output format for the particulate cloud option is designed for both single main rotor and twin-rotor aircraft as shown in figure D-34. In this example, using the XV-15, the particulate cloud boundaries located at the 90- and 270-degree azimuths (out the span of the wing) are specified by the single rotor or "SR" row of output values. The interaction plane or "IP" row defines the cloud boundaries which exist straight out in front of and directly aft of the aircraft along the aircraft centerline. If a single main rotor configuration is being evaluated, the "IP" row in the printout will contain all zeros.

ENTER TERRAIN EROSION FACTOR (-ND-) ==> 0.4				
SUMMARY OF CLOUD BOUNDARIES				
RC AND RV ARE FROM ROTOR CENTER (FT)				
	RC	RV	ZV	HC
SR	80.1	62.8	26.3	37.6
IP	113.0	88.7	37.2	53.0
QSMAX = 13.5 PSF				
TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==				

FIGURE D-34 PARTICULATE CLOUD ANALYSIS OPTION OUTPUT

#### D.2 ROTWASH PROGRAM DATA OUTPUT FILE FORMATS

Four data output file formats can be specified from the ROTWASH program for use with computer graphics programs. Two of these output file formats are generated by the wall jet and interaction plane velocity profile analysis options. The other two formats are generated by the personnel overturning force and moment option. These file formats save the summary force and moment data for both the wall jet and interaction plane cases.

The first two lines in each of the four file formats are user-specified comments. These two comment lines are typed in through use of the program logic/comment menu. The rest of the data in each of the file formats is either header information or engineering data. The example files presented in this section are written for direct input to the TECPLT Graphics Program which is written by AMTEC Engineering. This graphics program is one of several IBM PC/PC-compatible engineering graphics programs

presently on the market. Users that do not have access to this program can easily modify the ROTWASH FORTRAN code for other types of graphics programs by modifying the appropriate write statements. Table 1 provides the user with a cross reference of the figure number for each of the four output types and the source location for the associated FORTRAN code that can be modified (see program listings in appendix E).

TABLE D-1 GRAPHICS FILE/SOURCE CODE REFERENCE MATRIX

FILE OUTPUT TYPE	FIGURE	SOURCE CODE LOCATION
Wall Jet Velocity Profile Output	D-35	Subroutine WJVEL
Interaction Plan Velocity Profile Output	D-36	Subroutine IPVEL
OVERTURNING FORCE/MOMENT SUMMARY (Wall Jet)	D-37	Subroutine HWJVEL
OVERTURNING FORCE/MOMENT SUMMARY (Interaction Plan)	D-38	Subroutine HIPVEL

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA  
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="VELOCITY PROFILE, DPRC = 50.0 FT, GW = 13000 LB, WAGL = 25.0 FT"  
VARIABLES = X,HT  
ZONE T = "MEAN PROFILE, KTS", I=11, F=POINT  
.0 .00  
25.1 1.00  
23.9 2.00  
19.0 3.00  
14.7 4.00  
11.0 5.00  
7.8 6.00  
5.2 7.00  
3.2 8.00  
1.6 9.00  
.6 10.00  
ZONE T = "PEAK PROFILE, KTS", I=11, F=POINT  
.0 .00  
46.8 1.00  
48.2 2.00  
44.0 3.00  
38.5 4.00  
35.5 5.00  
30.4 6.00  
23.7 7.00  
16.3 8.00  
9.3 9.00  
3.7 10.00  
ZONE T = "PEAK Q, PSF", I=11, F=POINT  
.0 .00  
7.4 1.00  
7.8 2.00  
6.6 3.00  
5.0 4.00  
4.3 5.00  
3.1 6.00  
1.9 7.00  
.9 8.00  
.3 9.00  
.0 10.00

FIGURE D-35 EXAMPLE WALL JET OPTION GRAPHICS FILE FORMAT

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA  
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="VELOCITY PROFILE, DAIP = 50.0 FT, GW = 13000 LB, WAGL = 25.0 FT"  
VARIABLES = X,HT  
ZONE T = "MEAN PROFILE, KTS", I=11, F=POINT

.0	.00
37.7	1.00
39.5	2.00
39.0	3.00
38.5	4.00
37.9	5.00
37.4	6.00
36.8	7.00
36.3	8.00
35.7	9.00
35.1	10.00

ZONE T = "PEAK PROFILE, KTS", I=11, F=POINT

.0	.00
61.6	1.00
64.6	2.00
63.7	3.00
62.9	4.00
62.0	5.00
61.1	6.00
60.2	7.00
59.3	8.00
58.3	9.00
57.4	10.00

ZONE T = "PEAK Q, PSF", I=11, F=POINT

.0	.00
12.9	1.00
14.1	2.00
13.7	3.00
13.4	4.00
13.0	5.00
12.6	6.00
12.3	7.00
11.9	8.00
11.5	9.00
11.1	10.00

FIGURE D-36 EXAMPLE INTERACTION PLANE OPTION GRAPHICS FILE FORMAT

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA  
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="SINGLE ROTOR DFRC DATA"  
VARIABLES = DFRC,TOTF,TOTM  
ZONE T = "GW = 13000 LB, WAGL = 25.0 FT", I=6, F=POINT

50.00	42.72	114.60
60.00	33.71	91.72
70.00	25.05	69.35
80.00	17.52	49.89
90.00	11.51	33.38
100.00	6.93	20.27

FIGURE D-37 EXAMPLE PERSONNEL OVERTURNING FORCE AND MOMENT  
GRAPHICS FILE FORMAT CREATED WITH THE WALL JET ANALYSIS OPTION

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA  
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="TWIN ROTOR DAIP DATA"  
VARIABLES = DAIP,TOTF,TOTM  
ZONE T = "GW = 13000 LB, WAGL = 25.0 FT", I=6, F=POINT  
50.00 94.05 288.66  
60.00 83.94 259.37  
70.00 73.00 227.47  
80.00 62.43 196.32  
90.00 52.82 167.46  
100.00 44.26 141.31

FIGURE D-38 EXAMPLE PERSONNEL OVERTURNING FORCE  
AND MOMENT GRAPHICS FILE FORMAT CREATED  
WITH THE INTERACTION PLANE ANALYSIS OPTION

#### LIST OF REFERENCES

- D-1. Ferguson, S.W., and J.D. Kocurek, "Analysis and Recommendation of Separation Requirements for Rotorcraft Operation at Airports and Heliports," Systems Technology, Inc, Report TR-1224-1, September 1986.
- D-2. Ferguson S.W., "Evaluation of Rotorwash Characteristics for Tiltrotor and Tiltwing Aircraft in Hovering Flight," U.S. Department of Transportation, Federal Aviation Administration, DOT/FAA/RD-90/16, December 1990.
- D-3. Harris, D.J., and R.D. Simpson, "Technical Evaluation of the Rotor Downwash Flow Field of the XV-15 Tilt Rotor Research Aircraft," Naval Air Test Center, Technical Report No. SY-14R-83, July 1983.
- D-4. Harris, D.J., and R.D. Simpson, "CH-53E Helicopter Downwash Evaluation. Final Report," Naval Air Test Center, Technical Report No. SY-89R-78, August 1978.
- D-5. Harris, D.J., and R.D. Simpson, "CL-84 Tilt-Wing Vertical and Short Takeoff and Landing Downwash Evaluation. Final Report," Naval Air Test Center, Technical Report No. SY-52R-76, April 1976.
- D-6. Hoerner, S.F., Fluid-Dynamic Drag, Published by Author, 1958.

APPENDIX E  
ROTWASH PROGRAM FORTRAN 77 LISTINGS

ROTWASH program listings are presented in this appendix for the ROTWASH main program and its 24 subroutines. The listings are for a version of the program that is run on IBM PC/PC-compatible computers using MICROSOFT FORTRAN 77, Version 5.0. The tabular listing below indexes subroutine names and briefly describes functionality for user reference.

<u>SUBROUTINE</u>	<u>FUNCTION</u>
ROTWASH	Main Program Driver and Initialization
CLOUD	Calculates Particle Cloud Boundaries
DFVTX	Locates Disk Edge Vortex System and Calculates Induced Velocity Field
FREAD	Prompt/Validate for Floating Point Input Data
GDVTX	Locates Ground Vortex System and Calculates Induced Velocity Field
HAZARD	Driver Subroutine for Hazard Analysis
HIPVEL	Twin Rotor Overturning Forces and Moments
HOMCLS	Home Cursor and Clear Screen
HSVTX	Calculates Induced Velocity Field of a Horseshoe Vortex System
HWJVEL	Single Rotor Overturning Forces and Moments
INKEY	Menu Input Data Control
INPUT	Rotorcraft Characteristics Input Data Menu
INPUTV	Velocity Profile Status Menu
INPUTX	Ground/Disk Vortex Input Data Menu
IOFNSH	Close Disk I/O Files
IOINIT	File I/O Management Menu
IPVEL	Calculates Interaction Plane Velocity Profile
IREAD	Prompt/Validate for Integer Input Data
LEGAL	Check Validity of Input Data Selection Codes
LOCATE	Locate Cursor Position
MOMENT	Calculates Personnel Overturning Forces and Moments
PROPRM	Calculates Radial Wall Jet Velocity Profile
VLINE	Calculates Induced Velocity from a Line Vortex Field
WALJET	Defines Initial Wall Jet Position and Growth Parameters
WJVEL	Calculates Single Rotor Velocity Profile

## PROGRAM ROTWASH

```
1 C
2 C
3 C     PROGRAM ROTWASH
4 C
5 C     ****
6 C     ROTORCRAFT DOWNWASH HAZARD ANALYSIS PROGRAM
7 C
8 C     EMA
9 C     SAMUEL W. FERGUSON
10 C
11 C     1 APRIL 1993
12 C
13 C     PROGRAM VERSION 2.1
14 C
15 C     THIS PROGRAM WAS DEVELOPED USING MICROSOFT FORTRAN 77 FOR
16 C     THE DOS OPERATING SYSTEM. CONSOLE DISPLAY CONTROL IS
17 C     PROVIDED WITH THIS PROGRAM IN SEVERAL SPECIAL SUBROUTINES.
18 C     ****
19 C
20 C     PARAMETER (NUM = 10)
21 C
22 C     CHARACTER*1 OKLIST (NUM)
23 C     CHARACTER*1 KEY,KKEY,FLOW,VELHAZ,HAZTYP
24 C     CHARACTER*1 ICONT(5)
25 C     CHARACTER*1 TEMCHAR
26 C     CHARACTER*12 PTSFIL(4)
27 C     CHARACTER*50 COMM(2)
28 C     REAL*4 KE
29 C
30 C     DIMENSION CONT(9),CONTV(7),CONTX(8)
31 C
32 C     COMMON / CKEY/ KEY,KKEY
33 C     COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
34 C     COMMON /HELGE0/ H,DL,YSEP,WSPD,RADIUS,SHFTAN,DXO
35 C     COMMON /INPUTC/ ICONT,COMM,PTSFIL
36 C     COMMON /INPUTD/ CONT,CONTV,CONTX,YBDLAY
37 C     COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
38 C     COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
39 C
40 C     DATA CONT/2.0,32.2,12.5,12475.0,13.0,37.5,0.0,1.0,0.0/
41 C     DATA CONT/1.0,0.0,39.5,56000.0,5.0,600.0,0.0,0.975,0.0/
42 C     DATA YBDLAY/1.5/
43 C     DATA ICONT/'V','N','N','W','L'/
44 C     DATA CONTV/59.3,1.0,10.0,50.0,10.0,100.0,0.0/
45 C     DATA CONTX/733.0,7.0,50.0,200.0,0.0,20.0,100.0,0.0/
46 C     DATA PTSFIL/'DFRC.PTS' 'DAIP.PTS','OTDFRC.PTS','OTDAIP.PTS'/
47 C     DATA COMM/
48 C     1 'XV-15 CHARACTERISTICS ARE USED AS INPUT DATA ',
49 C     2 'GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS  '
50 C
51 C     DATA OKLIST /'W','w','I','i','G','g','D','d','X','x'/
52 C
53 C     ****
54 C
55 C     -----
56 C     INITIALIZE I/O SYSTEM
57 C     -----
58 C
59 C     CALL IOINIT
60 C
61 C     -----
62 C     INITIALIZE MISCELLANEOUS CONSTANTS
63 C     -----
```

## PROGRAM ROTWASH

```
64 C
65 PI      = ACOS(-1.0)
66 RHOSL   = 0.0023769
67 FPSPKN  = 1.687
68 DRC     = 0.01745329252
69 C
70 50 CONTINUE
71 C
72 KEY    = ' '
73 KKEY= ' '
74 C
75 C
76 C OBTAIN INPUT DATA PARAMETERS FROM STATUS SCREEN
77 C
78 C
79 C CALL INPUT
80 C
81 C
82 C DEFINE PARAMETERS OBTAINED FROM SUBROUTINE INPUT
83 C
84 C
85 ROTORS = CONT(1)
86 YYSEP  = CONT(2)
87 RADIUS  = CONT(3)
88 HELGW   = CONT(4)
89 DWNLD   = CONT(5)
90 HAGL    = CONT(6)
91 SHFTAN  = CONT(7)
92 SIGPR   = CONT(8)
93 WSPD    = CONT(9)
94 C
95 VELHAZ = ICONT(1)
96 C
97 C
98 C ADJUST GEOMETRY IF SHAFT ANGLE > 0.0 DEGREES
99 C
100 C
101 RSHFT  = SHFTAN*DRC
102 CSHFTA = COS(RSHFT)
103 DXO    = HAGL*TAN(RSHFT)
104 C
105 C
106 C NON-DIMENSIONALIZE SOME OF THE INPUT PARAMETERS
107 C
108 C
109 H      = HAGL/RADIUS/CSHFTA
110 YSEP  = YYSEP/2.0/RADIUS
111 EFGW   = HELGW*(1.0 + (DWNLD/100.0))
112 DL    = EFGW/ROTORS/PI/RADIUS**2
113 RHO   = SIGPR*RHOSL
114 RHOD2 = 0.5*RHO
115 C
116 C
117 C SWITCHING CALLS HAZARD PROGRAM AND ALLOWS RETURN (IF DESIRED)
118 C TO THE MAINLINE ROUTINE TO CHANGE ROTORCRAFT INPUT PARAMETERS
119 C
120 C
121 IF(VELHAZ.EQ.'H') THEN
122 C
123 KKEY = 'H'
124 CALL HAZARD(HAZTYP)
125 C
126 IF(KEY.EQ.'X') GOTO 999
```

## PROGRAM ROTWASH

```

127      IF (FLOW.EQ.'X') GOTO 999
128      IF (HAZTYP.EQ.'X') GOTO 999
129      GOTO 50
130  C
131  C      ELSE
132  C
133  C      KKEY = 'V'
134  C
135  C      END IF
136  C
137  C      -----
138  C      SELECT FLOWFIELD OPTION
139  C      -----
140  C
141  10 CONTINUE
142  C
143  C      -----
144  C      HOME CURSOR AND CLEAR SCREEN
145  C      -----
146  C
147  C      ICD = 0
148  C      CALL HOMCLS(ICD)
149  C      CALL LOCATE(3,1)
150  C
151  C      WRITE (IOU1,11)
152  11 FORMAT ( 20X,' SELECT TYPE OF FLOW TO BE ESTIMATED',//,
153  1      20X,'WALL JET PROFILE,          TYPE <W>',//,
154  2      20X,'INTERACTION PLANE PROFILE,  TYPE <I>',//,
155  2      20X,'GROUND VORTEX,           TYPE <G>',//,
156  2      20X,'DISK VORTEX,             TYPE <D>',//,
157  3      20X,'TO EXIT PROGRAM,        TYPE <X>',//)
158  C
159  C      -----
160  C      PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT
161  C      -----
162  C
163  40 CONTINUE
164  C
165  C      WRITE (IOU1,'(23X,A,$)')
166  1      ' ENTER DATA ENTRY CODE    ==> '
167  C
168  C      READ (IOU1,'(A1)') FLOW
169  C
170  C      IF (LEGAL(FLOW,IOU1,OKLIST,NUM).EQ.1) GOTO 40
171  C
172  C
173  C      MAKE LEGAL LOWERCASE INPUTS UPPERCASE BEFORE BRANCHING
174  C      -----
175  C
176  C      IF (FLOW.EQ.'w') FLOW = 'W'
177  C      IF (FLOW.EQ.'i') FLOW = 'I'
178  C      IF (FLOW.EQ.'g') FLOW = 'G'
179  C      IF (FLOW.EQ.'d') FLOW = 'D'
180  C      IF (FLOW.EQ.'x') FLOW = 'X'
181  C
182  C      -----
183  C      HOME CURSOR AND CLEAR SCREEN
184  C      -----
185  C
186  C      ICD = 0
187  C      CALL HOMCLS(ICD)
188  C
189  C      -----

```

## PROGRAM ROTWASH

```
190 C      BRANCH BASED ON CHOSEN OPTION, ALSO
191 C      CHECK NUMBER OF ROTORS TO LIMIT SOME OPTIONS
192 C      -----
193 C
194 IF(FLOW.EQ.'X')GOTO 999
195 IF(FLOW.EQ.'W')GOTO 12
196 C
197 IF(FLOW.EQ.'I')THEN
198   IF(ROTORS.GT.1.0)GOTO 12
199   WRITE(IOU1,'(//,,14X,A,$)')
200   1 ' REQUIRES TWO ROTORS, TYPE <RETURN> TO CONTINUE '
201   READ(IOU1,'(A1)') TEMCHAR
202   GOTO 10
203 ENDIF
204 C
205 IF(FLOW.EQ.'G')THEN
206   IF(ROTORS.LT.2.0)GOTO 1000
207   WRITE(IOU1,'(//,,14X,A,$)')
208   1 ' REQUIRES ONE ROTOR, TYPE <RETURN> TO CONTINUE '
209   READ(IOU1,'(A1)') TEMCHAR
210   GOTO 10
211 ENDIF
212 C
213 IF(FLOW.EQ.'D')THEN
214   IF(ROTORS.LT.2.0)GOTO 1000
215   WRITE(IOU1,'(//,,14X,A,$)')
216   1 ' REQUIRES ONE ROTOR, TYPE <RETURN> TO CONTINUE '
217   READ(IOU1,'(A1)') TEMCHAR
218   GOTO 10
219 ENDIF
220 C
221 GOTO 10
222 C
223 12 CONTINUE
224 C      ****
225 C      RADIAL WALL JET FLOWS
226 C      ****
227 C
228 C      -----
229 C      ACCELERATED SLIPSTREAM MEAN VELOCITY
230 C      -----
231 C
232 C
233 UN = SQRT(2.0*DL/RHO)
234 C
235 C      -----
236 C      GROUND EFFECT CORRECTION
237 C      -----
238 C
239 AKG = 1.0 - 0.9*EXP(-2.0*H)
240 C
241 C      -----
242 C      MEAN VELOCITY AT ROTOR DISK (RATIOED TO UN)
243 C      -----
244 C
245 UB = AKG/2.0
246 C
247 C      -----
248 C      FIND INITIAL RADIUS OF WALL JET
249 C      -----
250 C
251 CALL WALJET(H,UB,UN,UMB)
252 C
```

## PROGRAM ROTWASH

```
253      500 CONTINUE
254      C
255      IF (KEY.EQ.'X')GOTO 999
256      IF (KEY.EQ.'N')GOTO 50
257      IF (FLOW.EQ.'I')GOTO 700
258      C
259      600 CONTINUE
260      C
261      -----
262      C      WALL JET REGION
263      C
264      C      OBTAIN INPUT DATA FOR THE WALL JET OPTION
265      C      -----
266      C
267      CALL INPUTV(FLOW)
268      C
269      RVZ      = (CONTV(1) - DXO)/RADIUS
270      DELZ     = CONTV(2)/RADIUS
271      ZMAX     = CONTV(3)/RADIUS
272      BDLAYM   = YBDLAY/RADIUS
273      C
274      -----
275      C      GENERATE VELOCITY PROFILE AT RVZ IN WALL JET REGION
276      C      -----
277      C
278      CALL WJVEL(H,UN,UMB,RVZ,RADIUS,WSPD,DELZ,ZMAX,DXO,BDLAYM)
279      C
280      GOTO 500
281      C
282      700 CONTINUE
283      C
284      -----
285      C      INTERACTION PLANE UPWASH DEFLECTION ZONE
286      C
287      C      OBTAIN INPUT DATA FOR THE IPLANE OPTION
288      C      -----
289      C
290      CALL INPUTV(FLOW)
291      C
292      XIP      = (CONTV(1) - DXO)/RADIUS
293      DELZ     = CONTV(2)/RADIUS
294      ZMAX     = CONTV(3)/RADIUS
295      BDLAYM   = YBDLAY/RADIUS
296      C
297      -----
298      C      GENERATE VELOCITY PROFILE AT XIP IN INTERACTION PLANE
299      C      -----
300      C
301      CALL IPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELZ,ZMAX,DXO,BDLAYM)
302      C
303      GOTO 500
304      C
305      1100 CONTINUE
306      C
307      IF (KEY.EQ.'X')GOTO 999
308      IF (KEY.EQ.'N')GOTO 50
309      C
310      1000 CONTINUE
311      C
312      C      ****
313      C      HORSESHOE VORTEX FLOWS
314      C      ****
315      C
```

## PROGRAM ROTWASH

```
316 C -----
317 C      OBTAIN INPUT DATA FOR VORTEX OPTIONS
318 C -----
319 C
320 C      CALL INPUTX
321 C
322 C      OMEGAR = CONTX(1)
323 C      B      = CONTX(2)
324 C      VF     = CONTX(3)
325 C      XT     = CONTX(4)/RADIUS
326 C      YT     = CONTX(5)/RADIUS
327 C      DELZ   = CONTX(6)/RADIUS
328 C      ZMAX   = CONTX(7)/RADIUS
329 C
330 C      VF = VF*FPSPKN
331 C      AMU = VF/OMEGAR
332 C      CT  = DL/RHO/OMEGAR**2
333 C
334 C -----
335 C      ITERATE TO GET INFLOW RATIO
336 C -----
337 C
338 C      ALOLD = SQRT(CT/2.0)
339 C
340 C      DO 1300 ITER=1,100
341 C
342 C      ALNEW = CT/2.0/SQRT(ALOLD**2 + AMU**2)
343 C
344 C      IF (ABS(ALNEW - ALOLD).LE.1.0E-05) GOTO 1301
345 C
346 C      ALOLD = ALNEW
347 C
348 1300 CONTINUE
349 C
350 C -----
351 C      HOME CURSOR AND CLEAR SCREEN
352 C -----
353 C
354 C      ICD = 0
355 C      CALL HOMCLS(ICD)
356 C      CALL LOCATE(5,1)
357 C
358 C      WRITE(IOU1,20)
359 20 FORMAT( '*****',/
360 1      , 'ITERATIONS EXCEEDED FOR INFLOW RATIO',/
361 2      , '*****')
362 C
363 C      STOP ''
364 C
365 1301 CONTINUE
366 C
367 C      ALAMDA = ALNEW
368 C      AMUS  = AMU/SQRT(CT/2.0)
369 C      GAMT  = OMEGAR*RADIUS*2.0*PI*CT/B
370 C      CHI   = ATAN(ALAMDA/AMU)/2.0
371 C
372 C -----
373 C      GAMWP IS FOR UNIFORM LOADING IN FORWARD FLIGHT.
374 C      0.625 FACTOR COMES FROM UNPUBLISHED FAA FLIGHT TEST DATA.
375 C      IF SETTLING ANGLE CHI <= 8.0 DEGREES, THEN USE GAMWP AS IS.
376 C      IF > 8.0 DEGREES, THEN REDUCE GAMWP BY THE LINEAR
377 C      RATE OF 6.5% PER DEGREE OF SETTLING ANGLE. THE REDUCTION
378 C      IS A SIMPLE APPROXIMATION FOR THE NEAR TERM THAT IS BASED
```

## PROGRAM ROTWASH

```
379 C ON AN ANALYSIS OF THE UNPUBLISHED FAA FLIGHT TEST DATA.  
380 C MODS MADE FEBRUARY 1993.  
381 C -----  
382 C  
383 C KE = 0.625  
384 C GAMWP = PI*RADIUS*OMEGAR**2*CT/VF/2.0/KE  
385 C  
386 C IF(CHI.LE.0.139616) THEN  
387 C GAMW = GAMWP  
388 C ELSE  
389 C GAMW = GAMWP*(1.0 - (CHI - 0.139616)*0.065*57.3)  
390 C IF(GAMW.LT.0.0) GAMW = 0.0  
391 C ENDIF  
392 C  
393 C HOD = H/2.0  
394 C  
395 C -----  
396 C HOME CURSOR AND CLEAR SCREEN  
397 C -----  
398 C  
399 C ICD = 0  
400 C CALL HOMCLS(ICD)  
401 C CALL LOCATE(3, 1)  
402 C  
403 C IF(FLOW.EQ.'D') GOTO 1200  
404 C  
405 C -----  
406 C GROUND VORTEX  
407 C -----  
408 C  
409 C WRITE(IOU1,1001) HOD,AMUS,AMU  
410 C 1001 FORMAT( 18X,'ROTOR HEIGHT ABOVE GROUND H/D ',2X,F8.4,/)  
411 C 1 ,18X,'ADVANCE RATIO MU-STAR ',2X,F8.4,/)  
412 C 2 ,18X,'ADVANCE RATIO MU ',2X,F8.4,/) )  
413 C  
414 C -----  
415 C THE VALUE INPUT HERE REQUIRES USE OF THE CHART IN FIGURE 18  
416 C OF THE ACCOMPANYING DOCUMENTATION FOR THE GROUND VORTEX  
417 C -----  
418 C  
419 C 30 CONTINUE  
420 C  
421 C WRITE(IOU1,31)  
422 C 31 FORMAT( 18X,'ENTER GROUND VORTEX STRENGTH RATIO',//,  
423 C 1 25X,'(SEE FIGURE 18) ==> '$)  
424 C  
425 C READ(IOU1,*,ERR=30) GAMG  
426 C  
427 C IF(GAMG.LT.0.0) GAMG = 0.0  
428 C  
429 C -----  
430 C CONTINUE ANALYSIS  
431 C -----  
432 C  
433 C GAMG = GAMG*GAMT  
434 C  
435 C CALL GDVTX(H,RADIUS,AMU,CT,GAMG,XT,YT,DELZ,ZMAX)  
436 C  
437 C GOTO 1100  
438 C  
439 C 1200 CONTINUE  
440 C  
441 C -----
```

PROGRAM ROTWASH

```
442 C      DISK VORTEX
443 C      -----
444 C      CALL DEVTX(H,RADIUS,GAMW,CHI,XT,YT,DELZ,ZMAX)
445
446 C      GOTO 1100
447
448 C      -----
449 C      NORMAL PROGRAM EXIT
450 C      -----
451 C      -----
452 C      999 CONTINUE
453
454 C      END
455
456 C
457
```

## SUBROUTINE CLOUD

```

1  C
2  C
3  C      SUBROUTINE CLOUD (UN,UMB)
4  C
5  C      ****
6  C      SUBROUTINE CLOUD
7  C
8  C      THIS SUBROUTINE MAKES THE CALCULATIONS REQUIRED IN ESTIMATING
9  C      THE PARTICLE CLOUD BOUNDARIES ( NO DENSITIES ) FOR SINGLE AND
10 C      TWIN ROTOR CONFIGURATIONS
11 C      ****
12 C
13 C      CHARACTER*1 KEY,KKEY
14 C      CHARACTER*1 ICONT(5)
15 C      CHARACTER*12 PTSFIL(4)
16 C      CHARACTER*50 COMM(2)
17 C
18 C      COMMON / CKEY/ KEY,KKEY
19 C      COMMON /CLOUDK/ QSMAX
20 C      COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
21 C      COMMON /HELGE0/ H,DL,YSEP,WSPD,RADIUS,SHFTAN,DXO
22 C      COMMON /INPUTC/ ICONT,COMM,PTSFIL
23 C      COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
24 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
25 C
26 C      ****
27 C
28 C      -----
29 C      CLEAR SCREEN AND HOME CURSOR
30 C      -----
31 C
32 C      ICD = 0
33 C      CALL HCMCLS(ICD)
34 C      CALL LOCATE(3,1)
35 C
36 C      -----
37 C      READ IN THE TERRAIN FACTOR CONSTANT
38 C      (SEE FIGURE 30 OF USER'S GUIDE)
39 C      -----
40 C
41 C      10 CONTINUE
42 C
43 C      WRITE (IOU1,20)
44 C      20 FORMAT( 15X,'ENTER TERRAIN EROSION FACTOR (-ND-) --> ',\$)
45 C
46 C      READ (IOU1,*,ERR=10) XKT
47 C
48 C      -----
49 C      VALIDATE REAL INPUT VALUE
50 C      -----
51 C
52 C      IF (XKT.LE.0.0.OR.XKT.GT.500.0) GOTO 10
53 C
54 C      -----
55 C      DEFINE CLOUD BOUNDARY CONSTANTS
56 C      -----
57 C
58 C      XKT = SQRT(XKT)
59 C
60 C      QSMX = RHOD2*((SQRT(QSMAX)*UN)**2)
61 C      ERC = -0.437
62 C      XUM = (UMB*UN)**2
63 C      XCU = CU*CU

```

## SUBROUTINE CLOUD

```

64      C1 = 1.0
65      C2 = 2.2
66      C
67      C -----
68      C SINGLE ROTOR CLOUD BOUNDARY CALCULATIONS
69      C -----
70      C
71      RCR = RADIUS*((XKT/(C1*RHOD2*XUM*XCU))**ERC)
72      RVR = 0.785*RCR
73      ZVR = 0.329*RCR
74      RCVR = RCR - RVR
75      AR = (2.0/PI)*ALOG(ZVR/RCVR)
76      PHIR = (PI/2.0)*ALOG(RCVR)/ALOG(ZVR/RCVR)
77      AXLV = AR*((-PI/2.0) + PHIR)
78      XLV = EXP(AXLV)
79      HCR = XLV + ZVR
80      C
81      C -----
82      C INITIALIZE INTERACTION PLANE BOUNDARIES
83      C -----
84      C
85      RCI = 0.0
86      RVI = 0.0
87      ZVI = 0.0
88      HCI = 0.0
89      IF(YSEP.LE.0.1)GOTO 30
90      C
91      C -----
92      C INTERACTION PLANE CLOUD BOUNDARY CALCULATIONS
93      C -----
94      C
95      RCI = RADIUS*((XKT/(C2*RHOD2*XUM*XCU))**ERC)
96      RVI = 0.785*RCI
97      ZVI = 0.329*RCI
98      RCVR = RCI - RVI
99      AR = (2.0/PI)*ALOG(ZVI/RCVR)
100     PHIR = (PI/2.0)*ALOG(RCVR)/ALOG(ZVI/RCVR)
101     AXLV = AR*((-PI/2.0) + PHIR)
102     XLV = EXP(AXLV)
103     HCI = XLV + ZVI
104     C
105     30 CONTINUE
106     C
107     C -----
108     C PRINTOUT OF BOUNDARY LIMITS
109     C -----
110     C
111     IF(IOU6.NE.IOU1) WRITE(IOU6,'(''1'')
112     C
113     C -----
114     C WRITE "40 FORMAT" IF OUTPUT TO GRAPHICS FILE
115     C -----
116     C
117     IF(IOU6.EQ.6) WRITE(IOU6,40) COMM(1),COMM(2)
118     40 FORMAT( 10X,A50,/,10X,A50,/)
119     C
120     WRITE(IOU6,50)
121     50 FORMAT( //,
122     1      20X,' SUMMARY OF CLOUD BOUNDARIES',//,
123     2      20X,' RC AND RV ARE FROM ROTOR CENTER (FT',//,
124     3      20X,' RC ',7X,' RV ',7X,' ZV ',7X,' HC ',/
125     C
126     WRITE(IOU6,60) RCR,RVR,ZVR,HCR

```

## SUBROUTINE CLOUD

```
127      60 FORMAT( 13X,'SR',F10.1,3F11.1)
128      C
129      WRITE( IOU6,70) RCI,RVI,ZVI,HCI
130      70 FORMAT( 13X,'IP',F10.1,3F11.1)
131      C
132      WRITE( IOU6,80) QSMX
133      80 FORMAT( /,12X,' QSMAX =',F7.1,' PSF',//)
134      C
135      -----
136      C      DECIDE NEXT OPTION WITH INKEY
137      C
138      C
139      CALL INKEY
140      C
141      RETURN
142      END
143      C
```

## SUBROUTINE DEVTX

```

1  C
2  C
3  C      SUBROUTINE DEVTX(H,RADIUS,GAMW,CHI,XT,YT,DELZ,ZMAX)
4  C
5  C      ****
6  C      SUBROUTINE DEVTX
7  C
8  C      THIS SUBROUTINE LOCATES THE DISK EDGE VORTEX SYSTEM, AND
9  C      DIRECTS THE CALCULATION OF ITS INDUCED VELOCITY FIELD
10 C      ****
11 C
12 C      CHARACTER*1 TEMCHAR
13 C      CHARACTER*1 KEY,KKEY
14 C      CHARACTER*1 ICONT(5)
15 C      CHARACTER*12 PTSFIL(4)
16 C      CHARACTER*50 COMM(2)
17 C
18 C      COMMON / CKEY/ KEY,KKEY
19 C      COMMON /CHSVTX/ XL1,YL1,ZL1,XL2,YL2,ZL2,XL3,YL3,ZL3,
20 C                      XR1,YR1,ZR1,XR2,YR2,ZR2,XR3,YR3,ZR3
21 C      COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
22 C      COMMON /INPUTC/ ICONT,COMM,PTSFIL
23 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
24 C
25 C      ****
26 C
27 C
28 C      -----ASSUME HORSESHOE SHAPE - ASSIGN LEFT AND RIGHT CORNERS-----
29 C
30 C
31 C      XL1 = 0.0
32 C      YL1 = -1.0
33 C      ZL1 = H
34 C
35 C      XR1 = 0.0
36 C      YR1 = 1.0
37 C      ZR1 = H
38 C
39 C
40 C      -----SET UP DIRECTION POINTERS FOR TRAILER ELEMENTS
41 C      POINT 2 IS AT GROUND IMPINGEMENT
42 C
43 C
44 C      XL2 = XL1 + H/TAN(CHI)
45 C      YL2 = YL1
46 C      ZL2 = 0.0
47 C
48 C      XR2 = XR1 + H/TAN(CHI)
49 C      YR2 = YR1
50 C      ZR2 = 0.0
51 C
52 C
53 C      -----POINT THREE EXTENDS TRAILER PARALLEL TO GROUND
54 C
55 C
56 C      XL3 = XL2 + 1.0
57 C      YL3 = YL2
58 C      ZL3 = ZL2
59 C
60 C      XR3 = XR2 + 1.0
61 C      YR3 = YR2
62 C      ZR3 = ZR2
63 C

```

## SUBROUTINE DEVTX

```

64      XT = XT*RADIUS
65      YT = YT*RADIUS
66      C
67      C -----
68      C CLEAR SCREEN AND HOME CURSOR
69      C -----
70      C
71      ICD = 0
72      CALL HOMCLS(ICD)
73      CALL LOCATE(4,1)
74      C
75      C -----
76      C WRITE OUTPUT HEADER
77      C -----
78      C
79      IF(IOU6.NE.IOU1) WRITE(IOU6,'("1")')
80      C
81      WRITE(IOU6,1000) XT,YT
82      1000 FORMAT( 21X,'DISK VORTEX VELOCITY PROFILE DATA',
83      1     '///,14X,' X-LOCATION (XT)      = ',2X,F8.2,2X,'FT',
84      2     ',14X,' Y-LOCATION (YT)      = ',2X,F8.2,2X,'FT',/)
85      C
86      C -----
87      C GAMW TO METRIC UNITS OF METERS**2/SEC
88      C -----
89      C
90      GAMWME = GAMW*0.092903
91      C
92      C -----
93      C 5-METER INITIAL CIRCULATION BASED ON 0.1D OR 0.2R CORE SIZE
94      C 5-METERS = 16.4042 FEET
95      C -----
96      C
97      RCD5M = 0.2*RADIUS/16.4042
98      GAMW5M = GAMWME*(1.0 - RCD5M*ATAN(1.0/RCD5M))
99      C
100     WRITE(IOU6,1001) GAMW,GAMWME,GAMW5M
101     1001 FORMAT( 15X,'VORTEX CIRCULATION      = ',F10.2,2X,'FT**2/SEC',/
102     1     15X,'VORTEX CIRCULATION      = ',F10.2,2X,'M**2/SEC',/
103     2     15X,'5-M INITIAL CIRCULATION = ',F10.2,2X,'M**2/SEC')
104     C
105     CHID = CHI*180.0/PI
106     C
107     WRITE(IOU6,1005) CHID
108     1005 FORMAT( 15X,'SETTLING ANGLE      = ',F10.2,2X,'DEG',///)
109     C
110     WRITE(IOU1,'(23X,A,$)')
111     1   ' PRESS <RETURN> TO CONTINUE '
112     C
113     READ(IOU1,'(A1)') TEMCHAR
114     C
115     CALL HOMCLS(ICD)
116     C
117     IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
118     93 FORMAT( 14X,A50,/,10X,A50,/)
119     C
120     WRITE(IOU6,1100)
121     1100 FORMAT( 12X,'HEIGHT',8X,'MEAN VELOCITY',5X,'MEAN Q',/,/
122     1     '0',12X,'(FT)',8X,'(FPS)',6X,'(KN)',5X,'(PSF'),/)
123     C
124     C -----
125     C SET UP SWEEP OF Z AT SPECIFIED X,Y
126     C DELZ AND ZMAX COME FROM A MAINLINE STATUS MENU

```

## SUBROUTINE DEVTX

```

127 C -----
128 C
129 XT = XT/RADIUS
130 YT = YT/RADIUS
131 NPTS = IFIX(ZMAX/DELZ) + 2
132 LINES = 0
133 C
134 DO 200 I=1,NPTS
135 C
136 LINES = LINES + 4
137 ZT = (I - 1)*DELZ
138 C
139 CALL HSVTX(XT,YT,ZT,VXF,VYF,VZF,GAMW,RADIUS)
140 C
141 ZZ = ZT*RADIUS
142 VTF = SQRT(VXF**2 + VYF**2 + VZF**2)
143 VXF = VXF/FPSPKN
144 VYK = VYF/FPSPKN
145 VZK = VZF/FPSPKN
146 VTK = VTF/FPSPKN
147 C
148 QX = RHOD2*VXF**2
149 QY = RHOD2*VYF**2
150 QZ = RHOD2*VZF**2
151 QT = RHOD2*VTF**2
152 C -----
153 C
154 C KEEP OUTPUT PAGE LENGTH TO SIZE OF SCREEN
155 C -----
156 C
157 IF (IOU6.EQ.IOU1) THEN
158   IF (LINES.LE.12) GOTO 100
159   LINES = 4
160   CALL INKEY
161   IF (KEY.NE.'C') GOTO 999
162   WRITE (IOU6,1100)
163 ENDIF
164 C
165 100 CONTINUE
166 C -----
167 C
168 C REPORT X COMPONENT OF VELOCITY
169 C -----
170 C
171 WRITE (IOU6,1101) ZZ,VXF,VXK,QX
172 1101 FORMAT( 9X,F8.2,2X,'X',3F10.3)
173 C -----
174 C
175 C REPORT Y COMPONENT OF VELOCITY
176 C -----
177 C
178 WRITE (IOU6,1102) VYF,VYK,QY
179 1102 FORMAT( 19X,'Y',3F10.3)
180 C -----
181 C
182 C REPORT Z COMPONENT OF VELOCITY
183 C -----
184 C
185 WRITE (IOU6,1103) VZF,VZK,QZ
186 1103 FORMAT( 19X,'Z',3F10.3)
187 C -----
188 C
189 C REPORT TOTAL VELOCITY

```

SUBROUTINE DEVTX

```
190  C      -----
191  C
192  WRITE (IOU6,1104) VTF,VTK,QT
193  1104 FORMAT( 19X,'T',3F10.3)
194  C
195  200 CONTINUE
196  C
197  CALL INKEY
198  C
199  999 CONTINUE
200  C
201  RETURN
202  END
203  C
```

## SUBROUTINE FREAD

```

1  C
2  C
3  C      SUBROUTINE FREAD (IOU1,PROMPT,VALUE,CONST)
4  C
5  C      ****
6  C      SUBROUTINE FREAD PROMPTS USER FOR A FLOATING
7  C      POINT DATA ENTRY AND CHECKS VALIDITY OF ENTRY
8  C      ****
9  C
10 C      PARAMETER (LAST=50)
11 C
12 C      CHARACTER*50 PROMPT,SHOWIT
13 C      CHARACTER*15 ENTRY,BLANK
14 C
15 C      DATA BLANK ''           '/'
16 C
17 C      ****
18 C
19 C
20 C      -----  
PROMPT USER FOR SCALED FLOATING POINT ENTRY.
21 C      FIND POSITION OF LAST NON-BLANK CHARACTER IN PROMPT,
22 C      THEN STORE RIGHT JUSTIFIED IN SHOWIT.
23 C
24 C
25 C      N = LAST + 1
26 C
27 C      10 IF(N.EQ.1)GOTO 20
28 C
29 C      N = N - 1
30 C
31 C      IF(PROMPT(N:N).EQ.' ')GOTO 10
32 C
33 C      20 JS = LAST - N
34 C
35 C      WRITE(SHOWIT,'(50A1)') (' ',J=1,JS),(PROMPT(I:I),I=1,N)
36 C
37 C
38 C      -----  
NOW ASK USER FOR DATA ENTRY
39 C
40 C
41 C      30 WRITE(IOU1,'(/,1X,A,G13.6)') SHOWIT,VALUE*CONST
42 C
43 C      WRITE(IOU1,'(/,8X,A,$)')
44 C      1 ' ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS    --> '
45 C
46 C      READ(IOU1,'(A)') ENTRY
47 C
48 C      IF(ENTRY.EQ.BLANK)RETURN
49 C
50 C      READ(ENTRY,'(BN,F15.0)',ERR=30) TEMP
51 C
52 C
53 C      -----  
CONSTANT CAN BE USED TO SCALE OR
54 C      OR CONVERT UNITS OF AN INPUT VALUE
55 C
56 C
57 C      VALUE = TEMP/CONST
58 C
59 C      RETURN
60 C      END
61 C

```

## SUBROUTINE GDVTX

```

1 C
2 C
3 C      SUBROUTINE GDVTX(H,RADIUS,AMU,CT,GAMG,XT,YT,DELZ,ZMAX)
4 C
5 C      ****
6 C      SUBROUTINE GDVTX
7 C
8 C      THIS SUBROUTINE LOCATES THE GROUND VORTEX BASED ON THE
9 C      EXPERIMENTS BY SUN AND CURTIS (PRINCETON UNIV.), AND THEN
10 C      DIRECTS THE CALCULATION OF ITS INDUCED VELOCITY FIELD
11 C
12 C      THE OUTPUT FROM THIS SUBROUTINE SHOULD BE USED CAREFULLY
13 C      FOR GROSS ESTIMATION PURPOSES ONLY
14 C      ****
15 C
16 C      CHARACTER*1 ICONT(5)
17 C      CHARACTER*1 TEMCHAR
18 C      CHARACTER*1 KEY,KKEY
19 C      CHARACTER*12 PTSFIL(4)
20 C      CHARACTER*50 COMM(2)
21 C
22 C      COMMON / CKEY/ KEY,KKEY
23 C      COMMON /CHSVTX/ X1,YL1,ZL1,XL2,YL2,ZL2,XL3,YL3,ZL3,
24 C                      XR1,YR1,ZR1,XR2,YR2,ZR2,XR3,YR3,ZR3
25 C      COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
26 C      COMMON /INPUTC/ ICONT,COMM,PTSFIL
27 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
28 C
29 C      ****
30 C
31 HOD   = H/2.0
32 C1    = 1.0 + 1.2086*HOD**0.4374
33 C2    = -0.2786*HOD**0.6757
34 ZGV   = -10.0*AMU + 0.6
35 XGV   = -(C1 + C2*(AMU/CT))**2
36 XXGV = XGV*RADIUS
37 ZZGV = ZGV*RADIUS
38 C
39 C
40 C      -----ASSUME HORSESHOE SHAPE - ASSIGN LEFT AND RIGHT CORNERS-----
41 C
42 C
43 XL1 = XGV
44 YL1 = -1.0
45 ZL1 = ZGV
46 C
47 XR1 = XGV
48 YR1 = 1.0
49 ZR1 = ZGV
50 C
51 C
52 C      -----SET UP DIRECTION POINTERS FOR TRAILER ELEMENTS-----
53 C
54 C
55 XL2 = XL1 + 1.0
56 YL2 = YL1
57 ZL2 = ZL1
58 C
59 XR2 = XR1 + 1.0
60 YR2 = YR1
61 ZR2 = ZR1
62 C
63 XL3 = XL2 + 1.0

```

## SUBROUTINE GDVTX

```

64      YL3 = YL2
65      ZL3 = ZL2
66      C
67      XR3 = XR2 + 1.0
68      YR3 = YR2
69      ZR3 = ZR2
70      C
71      C
72      C      WRITE OUT GROUND VORTEX POSITION/STRENGTH DATA
73      C      -----
74      C
75      IF (IOU6.NE.IOU1) WRITE (IOU6, (''1''))
76      C
77      WRITE (IOU6,1001) XXGV,ZZGV
78      1001 FORMAT( //,24X,'GROUND VORTEX CORE POSITION',//,
79      1 18X,'X-LOCATION (XXGV)           = ',1X,F8.2,2X,'FT',/
80      2 18X,'Y-LOCATION (ZZGV)           = ',1X,F8.2,2X,'FT')
81      C
82      WRITE (IOU6,1002) GAMG
83      1002 FORMAT( //,18X,'GROUND VORTEX CIRCULATION = ',1X,
84      1           F8.2,2X,'FT**2/SEC',//)
85      C
86      WRITE (IOU1,'(23X,A,$)')
87      1 ' PRESS <RETURN> TO CONTINUE '
88      C
89      READ (IOU1,'(A1)') TEMCHAR
90      C
91      ICD = 0
92      CALL HOMCLS(ICD)
93      C
94      C      -----
95      C      WRITE OUTPUT HEADER
96      C      -----
97      C
98      IF (IOU6.EQ.6) WRITE (IOU6,93) COMM(1),COMM(2)
99      93 FORMAT( 14X,A50,/,10X,A50,//)
100     C
101     WRITE (IOU6,1100)
102     1100 FORMAT( 12X,'HEIGHT',8X,'MEAN VELOCITY',5X,'MEAN Q',/,
103     1           '0',12X,'(FT)',8X,'(FPS)',6X,'(KN)',5X,'(PSF)',/)
104     C
105     C      -----
106     C      SET UP SWEEP OF Z AT SPECIFIED X,Y
107     C      DELZ AND ZMAX COME FROM MAINLINE STATUS SCREEN
108     C      -----
109     C
110     NPTS = IFIX(ZMAX/DELZ) + 2
111     LINES = 0
112     C
113     DO 200 I=1,NPTS
114     C
115     LINES = LINES + 4
116     ZT = (I - 1)*DELZ
117     C
118     CALL HSVTX(XT,YT,ZT,VXF,VYF,VZF,GAMG,RADIUS)
119     C
120     ZZ = ZT*RADIUS
121     VTF = SQRT(VXF**2 + VYF**2 + VZF**2)
122     VVK = VXF/FPSPKN
123     VVK = VYF/FPSPKN
124     VZK = VZF/FPSPKN
125     VTK = VTF/FPSPKN
126     C

```

## SUBROUTINE GDVTX

```
127      QX = RHOD2*VXF**2
128      QY = RHOD2*VYF**2
129      QZ = RHOD2*VZF**2
130      QT = RHOD2*VTF**2
131      C
132      IF (IOU6.EQ.IOU1) THEN
133          IF(LINES.LE.12)GOTO 100
134          LINES = 4
135          CALL INKEY
136          IF(KEY.NE.'C')GOTO 999
137          WRITE(IOU6,1100)
138      ENDIF
139      C
140      100 CONTINUE
141      C
142      C -----  
143      C REPORT X COMPONENT OF VELOCITY
144      C -----  
145      C
146      WRITE(IOU6,1101) ZZ,VXF,VXK,QX
147      1101 FORMAT( 9X,F8.2,2X,'X',3F10.3)
148      C
149      C -----  
150      C REPORT Y COMPONENT OF VELOCITY
151      C -----  
152      C
153      WRITE(IOU6,1102) VYF,VYK,QY
154      1102 FORMAT( 19X,'Y',3F10.3)
155      C
156      C -----  
157      C REPORT Z COMPONENT OF VELOCITY
158      C -----  
159      C
160      WRITE(IOU6,1103) VZF,VZK,QZ
161      1103 FORMAT( 19X,'Z',3F10.3)
162      C
163      C -----  
164      C REPORT TOTAL VELOCITY
165      C -----  
166      C
167      WRITE(IOU6,1104) VTF,VTK,QT
168      1104 FORMAT( 19X,'T',3F10.3)
169      C
170      200 CONTINUE
171      C
172      CALL INKEY
173      C
174      999 CONTINUE
175      C
176      RETURN
177      END
178      C
```

## SUBROUTINE HAZARD

```

1  C
2  C
3  C      SUBROUTINE HAZARD (HAZTYP)
4  C
5  C      ****
6  C      SUBROUTINE HAZARD IS THE MAINLINE DRIVER FOR THE
7  C      CALCULATION OF SPECIFIC HAZARDS
8  C      ****
9  C
10 C      PARAMETER (NUM1 = 6)
11 C      PARAMETER (NUM2 = 15)
12 C      PARAMETER (NUM3 = 4)
13 C      PARAMETER (NUM4 = 4)
14 C
15 C      CHARACTER*1 OKLST1 (NUM1)
16 C      CHARACTER*1 OKLST2 (NUM2)
17 C      CHARACTER*1 OKLST3 (NUM3)
18 C      CHARACTER*1 OKLST4 (NUM4)
19 C
20 C      CHARACTER*1 KEY, KKEY, HAZTYP, HUMTYP
21 C      CHARACTER*1 CHDOL, CVALUE
22 C      CHARACTER*1 ICONT (5)
23 C      CHARACTER*12 PTSFIL (4)
24 C      CHARACTER*12 TMPFIL
25 C      CHARACTER*50 COMM(2)
26 C      CHARACTER*50 PROMPT
27 C
28 C      DIMENSION COLP(9), CONTV(7), CONTX(8)
29 C
30 C      COMMON / CKEY / KEY, KKEY
31 C      COMMON / CONSTS / PI, RHO, FPSKPN, RHOD2, DRC
32 C      COMMON / HELGEO / H, DL, YSEP, WSPD, RADIUS, SHFTAN, DXO
33 C      COMMON / INPUTC / ICONT, COMM, PTSFIL
34 C      COMMON / INPUTD / CONT, CONTV, CONTX, YBDLAY
35 C      COMMON / PROFI / RJ, ZBJ, ZHJ, ZMJ, UMJ, ZB, ZH, ZM, UM, CU, CY
36 C      COMMON / UNITS / IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
37 C
38 C      ****
39 C
40 C      DATA OKLST1 /'C','c','M','m','X','x'/
41 C      DATA OKLST2 /' ','A','a','B','b','C','c','D','d',
42 C      1      'E','e','F','f','G','g'/
43 C      DATA OKLST3 /'W','w','I','i'/
44 C      DATA OKLST4 /'L','l','S','s'/
45 C
46 C      -----
47 C      CLEAR SCREEN AND HOME CURSOR
48 C      -----
49 C
50 C      ICD = 0
51 C      CALL HOMCLS(ICD)
52 C      CALL LOCATE(4,1)
53 C
54 C      -----
55 C      DETERMINE THE TYPE OF HAZARD ANALYSIS
56 C      OPTION THAT WILL BE EXECUTED
57 C      -----
58 C
59 C      WRITE (IOU1,10)
60 C      10 FORMAT ( 25X, ' SELECT TYPE OF HAZARD', //,
61 C      1      18X, 'OVERTURNING FORCE/MOMENT,      TYPE <M>', //,
62 C      2      18X, 'PARTICULATE CLOUDS,           TYPE <C>', //,
63 C      3      18X, 'TO EXIT PROGRAM,           TYPE <X>', //)

```

## SUBROUTINE HAZARD

```
64 C
65 C -----
66 C      INQUIRE, OBTAIN, AND CHECK FOR VALID MENU CODE
67 C -----
68 C
69 C      11 CONTINUE
70 C
71 C      WRITE(101,'(23X,A,$)') ' ENTER HAZARD CODE ==> '
72 C
73 C      READ(101,'(A1)') HAZTYP
74 C
75 C      IF(LEGAL(HAZTYP,101,OKLST1,NUM1).EQ.1)GOTO 11
76 C
77 C -----
78 C      CORRECT LOWER CASE LETTERS TO UPPER CASE
79 C      TO USE AS VALID FLAGS IN PARENT SUBROUTINE
80 C -----
81 C
82 C      IF(HAZTYP.EQ.'c') HAZTYP = 'C'
83 C      IF(HAZTYP.EQ.'m') HAZTYP = 'M'
84 C      IF(HAZTYP.EQ.'x') HAZTYP = 'X'
85 C
86 C -----
87 C      BRANCH IF EXIT OPTION CHOSEN
88 C -----
89 C
90 C      IF(HAZTYP.EQ.'M')GOTO 18
91 C      IF(HAZTYP.EQ.'C')GOTO 18
92 C      IF(HAZTYP.EQ.'X')GOTO 999
93 C
94 C      GOTO 11
95 C
96 C      18 CONTINUE
97 C
98 C      ****
99 C      RADIAL WALL JET FLOW INFORMATION
100 C      ****
101 C
102 C -----
103 C      ACCELERATED SLIPSTREAM MEAN VELOCITY
104 C -----
105 C
106 C      UN = SQRT(2.0*DL/RHO)
107 C
108 C -----
109 C      GROUND EFFECT CORRECTION
110 C -----
111 C
112 C      AKG = 1.0 - 0.9*EXP(-2.0*H)
113 C
114 C -----
115 C      MEAN VELOCITY AT ROTOR DISK (RATIOED TO UN)
116 C -----
117 C
118 C      UB = AKG/2.0
119 C
120 C -----
121 C      FIND INITIAL RADIUS OF WALL JET
122 C -----
123 C
124 C      CALL WALJET(H,UB,UN,UMB)
125 C
126 C      500 CONTINUE
```

## SUBROUTINE HAZARD

```

127 C
128 C     IF (KEY.EQ.'X')GOTO 999
129 C     IF (KEY.EQ.'N')GOTO 999
130 C
131 C     -----
132 C     BRANCH IF CLOUD OPTION CHOSEN
133 C     -----
134 C
135 C     IF (HAZTYP.EQ.'C')GOTO 800
136 C
137 C     ****
138 C     OVERTURNING FORCES/MOMENTS
139 C     ****
140 C
141 C     -----
142 C     DETERMINE:
143 C
144 C         1. THE AXIS ALONG WHICH THE OVERTURNING
145 C             FORCES/MOMENTS WILL BE CALCULATED
146 C
147 C         2. THE SIZE OF THE PERSON AFFECTED
148 C
149 C         3. THE DISTANCES AT WHICH THE OVERTURNING
150 C             FORCES/MOMENTS WILL BE CALCULATED
151 C
152 C     -----
153 C     20 CONTINUE
154 C
155 C     ICD = 0
156 C     CALL HOMCLS(ICD)
157 C     CALL LOCATE(2,1)
158 C
159 C     WRITE (IOU1,12)
160 C     12 FORMAT( 20X,' OVERTURNING FORCE/MOMENT DATA MENU',//,
161 C             1 10X,'CODE          PARAMETER          VALUE',
162 C             2      , ' UNITS',//)
163 C
164 C     -----
165 C     PRINT CUT MENU VARIABLES AS BASED ON THE WALL JET
166 C     OPTION OR INTERACTION PLANE OPTION SWITCH SETTING
167 C
168 C
169 C     IF (ICONT(4).EQ.'W')THEN
170 C
171 C         WRITE (IOU1,14) ICONT(4),ICONT(5),PTSFIL(3),
172 C                         CONTV(4),CONTV(5),CONTV(6),YBDLAY
173 C
174 C     ELSE
175 C
176 C         WRITE (IOU1,14) ICONT(4),ICONT(5),PTSFIL(4),
177 C                         CONTV(4),CONTV(5),CONTV(6),YBDLAY
178 C
179 C     ENDIF
180 C
181 C     14 FORMAT( 11X,'A      <W>ALL JET OR <I>NTERACTION PLANE',5X,A2,/,
182 C             1 11X,'B      <L>ARGE OR <S>MALL PERSON      ',5X,A2,/,
183 C             2 11X,'C      DATA OUTPUT FILENAME      ',2X,A12,/,
184 C             3 11X,''
185 C             4 11X,'D      INITIAL STATION POSITION      ',5X,F7.2,4X,'FT',/,
186 C             5 11X,'E      HORIZONTAL INCREMENT      ',5X,F7.2,4X,'FT',/,
187 C             6 11X,'F      MAXIMUM STATION POSITION      ',5X,F7.2,4X,'FT',/,
188 C             6 11X,'G      MINIMUM BOUNDARY LAYER HEIGHT ',5X,F7.2,4X,'FT',/)
189 C

```

## SUBROUTINE HAZARD

```
190  C -----  
191  C PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA  
192  C -----  
193  C  
194  16 CONTINUE  
195  C  
196  WRITE(IOU1,'(8X,A,$)')  
197  1' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> '  
198  C  
199  READ(IOU1,'(A1)') CHDOL  
200  C  
201  IF(LEGAL(CHDOL,IOU1,OKLST2,NUM2).EQ.1)GOTO 16  
202  C  
203  C -----  
204  C DIRECT OPTIONS BASED ON CHOICE FOR "CHDOL"  
205  C -----  
206  C  
207  IF(CHDOL.EQ.' ')GOTO 30  
208  C  
209  C -----  
210  C CHOOSE WALJET OR IPLANE OPTION  
211  C -----  
212  C  
213  IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a')THEN  
214  C  
215  40 CONTINUE  
216  C  
217  WRITE(IOU1,'(/,35X,A,1X,A2/)') ' ANALYSIS TYPE = ',ICONT(4)  
218  WRITE(IOU1,'(37X,A,$)') ' ENTER NEW CODE ==> '  
219  READ(IOU1,'(A1)') CVALUE  
220  C  
221  IF(LEGAL(CVALUE,IOU1,OKLST3,NUM3).EQ.1)GOTO 40  
222  C  
223  ICONT(4) = CVALUE  
224  IF(ICONT(4).EQ.'w') ICONT(4) = 'W'  
225  IF(ICONT(4).EQ.'i') ICONT(4) = 'I'  
226  GOTO 20  
227  C  
228  ENDIF  
229  C  
230  C -----  
231  C CHOOSE LARGE OR SMALL PERSON  
232  C -----  
233  C  
234  IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b')THEN  
235  C  
236  41 CONTINUE  
237  C  
238  WRITE(IOU1,'(/,35X,A,1X,A2/)') ' PERSON TYPE = ',ICONT(5)  
239  WRITE(IOU1,'(37X,A,$)') ' ENTER NEW CODE ==> '  
240  READ(IOU1,'(A1)') CVALUE  
241  C  
242  IF(LEGAL(CVALUE,IOU1,OKLST4,NUM4).EQ.1)GOTO 41  
243  C  
244  ICONT(5) = CVALUE  
245  IF(ICONT(5).EQ.'l') ICONT(5) = 'L'  
246  IF(ICONT(5).EQ.'s') ICONT(5) = 'S'  
247  GOTO 20  
248  C  
249  ENDIF  
250  C  
251  C -----  
252  C CHOOSE GRAPHICS FILENAME
```

```

253 C -----
254 C
255 C     IF (CHDOL.EQ.'C'.OR.CHDOL.EQ.'c') THEN
256 C
257 C         IF (ICONT(4).EQ.'W') THEN
258 C             WRITE (IOU1,'(/,25X,A,1X,A12/)')
259 C             ' FILENAME = ',PTSFIL(3)
260 C         ELSE
261 C             WRITE (IOU1,'(/,25X,A,1X,A12/)')
262 C             ' FILENAME = ',PTSFIL(4)
263 C         ENDIF
264 C
265 C         WRITE (IOU1,'(20X,A,$)')
266 C         1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) ==> '
267 C
268 C         READ (IOU1,'(A12)') TMPFIL
269 C
270 C         IF (ICONT(4).EQ.'W') PTSFIL(3) = TMPFIL
271 C         IF (ICONT(4).EQ.'I') PTSFIL(4) = TMPFIL
272 C         GOTO 20
273 C
274 C     ENDIF
275 C -----
276 C
277 C     CHOOSE INITIAL STATION POSITION
278 C -----
279 C
280 C     IF (CHDOL.EQ.'D'.OR.CHDOL.EQ.'d') THEN
281 C
282 C         PROMPT = ' INITIAL STATION POSITION = '
283 C         CALL FREAD (IOU1,PROMPT,CONTV(4),1.0)
284 C
285 C         IF (CONTV(4).LT.0.0) CONTV(4) = 0.0
286 C         GOTO 20
287 C
288 C     ENDIF
289 C -----
290 C
291 C     CHOOSE HORIZONTAL INCREMENT
292 C -----
293 C
294 C     IF (CHDOL.EQ.'E'.OR.CHDOL.EQ.'e') THEN
295 C
296 C         PROMPT = ' HORIZONTAL INCREMENT = '
297 C         CALL FREAD (IOU1,PROMPT,CONTV(5),1.0)
298 C
299 C         IF (CONTV(5).LT.0.0) CONTV(5) = 0.0
300 C         GOTO 20
301 C
302 C     ENDIF
303 C -----
304 C
305 C     CHOOSE HORIZONTAL INCREMENT
306 C -----
307 C
308 C     IF (CHDOL.EQ.'F'.OR.CHDOL.EQ.'f') THEN
309 C
310 C         PROMPT = ' MAXIMUM STATION POSITION = '
311 C         CALL FREAD (IOU1,PROMPT,CONTV(6),1.0)
312 C
313 C         IF (CONTV(6).LT.CONTV(4)) CONTV(6) = CONTV(4)
314 C         GOTO 20
315 C

```

## SUBROUTINE HAZARD

```

316      ENDIF
317      C
318      IF (CHDOL.EQ.'G'.OR.CHDOL.EQ.'g') THEN
319      C
320          PROMPT = 'MINIMUM BOUNDARY LAYER HEIGHT = '
321          CALL FREAD (IOU1, PROMPT, YBDLAY, 1.0)
322      C
323          IF (YBDLAY.LT.0.0) YBDLAY = 0.0
324          GOTO 20
325      C
326          ENDIF
327      C
328          GOTO 20
329      C
330      30 CONTINUE
331      C
332          ICD = 0
333          CALL HOMCLS (ICD)
334      C
335          IF (ICONT(4).EQ.'I') GOTO 700
336      C
337      600 CONTINUE
338      C
339      -----
340      C      WALL JET REGION
341      C
342      C      OBTAIN DATA FOR THE HWJVEL OPTION
343      C
344      C
345          RVZ      = (CONTV(4) - DXO)/RADIUS
346          DELH     = CONTV(5)
347          HMAX     = CONTV(6)
348          HUMTYP   = ICONT(5)
349          BDLAYM   = YBDLAY/RADIUS
350      C
351      C
352      C      GENERATE VELOCITY PROFILE AT RVZ IN WALL JET REGION
353      C
354      C
355          CALL
356          HWJVEL (H, UN, UMB, RVZ, RADIUS, WSPD, DELH, HMAX, HUMTYP, DXO, BDLAYM)
357      C
358          GOTO 500
359      C
360      700 CONTINUE
361      C
362      C
363      C      INTERACTION PLANE UPWASH DEFLECTION ZONE
364      C
365      C      OBTAIN INPUT DATA FOR THE HIPVEL OPTION
366      C
367      C
368          XIP      = (CONTV(4) - DXO)/RADIUS
369          DELH     = CONTV(5)
370          HMAX     = CONTV(6)
371          HUMTYP   = ICONT(5)
372          BDLAYM   = YBDLAY/RADIUS
373      C
374      C
375      C      GENERATE VELOCITY PROFILE AT XIP IN INTERACTION PLANE
376      C
377      C
378          CALL HIPVEL (H, UN, RADIUS, UMB, XIP, YSEP, WSPD, DELH, HMAX,

```

SUBROUTINE HAZARD

```
379      *      HUMTYP,DXO,BDLAYM)
380  C      GOTO 500
381  C
382  C      800 CONTINUE
383  C
384  C      ****
385  C      CALCULATE PARTICULATE CLOUD BOUNDARIES
386  C      ****
387  C
388  C
389  C      CALL CLOUD(UN,UMB)
390  C
391  C      GOTO 500
392  C
393  C      -----
394  C      NORMAL PROGRAM EXIT
395  C      -----
396  C
397  C      999 CONTINUE
398  C
399  C      RETURN
400  C      END
401  C
```

## SUBROUTINE HIPVEL

```

1  C
2  C
3  SUBROUTINE HIPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELH,
4  *          HMAX,HUMTYP,DXO,BDLAYM)
5  C
6  C
7  ****
8  C  SUBROUTINE HIPVEL GENERATES THE VELOCITY PROFILE AND THE FORCES
9  C  AND OVERTURNING MOMENTS FOR A HUMAN BEING ALONG THE INTERACTION
10 C  PLANE FOR THE TWIN ROTOR CASE
11 C
12 ****
13 C
14 C      CHARACTER*1 TEMCHAR
15 C      CHARACTER*1 KEY,KKEY,HUMTYP
16 C      CHARACTER*1 ICONT(5)
17 C      CHARACTER*12 PTSFIL(4)
18 C      CHARACTER*50 COMM(2)
19 C
20 C      COMMON / CKEY/ KEY,KKEY
21 C      COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
22 C      COMMON /INPUTC/ ICONT,COMM,PTSFIL
23 C      COMMON /PERSON/ QP(12),DSET
24 C      COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
25 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
26 C
27 C
28 ****
29 C
30 C      ICD = 0
31 C      CALL HOMCLS(ICD)
32 C
33 C      -----
34 C      INPUT FOR DELH AND HMAX COMES FROM INPUTV STATUS MENU
35 C      -----
36 C
37 C      DSET = DELH
38 C      IF(DSET.EQ.0.)DELH = HMAX
39 C
40 C      DELH = DELH/RADIUS
41 C      HMAX = HMAX/RADIUS
42 C      NHPTS = IFIX((HMAX - XIP)/DELH) + 1
43 C
44 C      IF(DSET.EQ.0.)GOTO 33
45 C
46 C      -----
47 C      WRITE OUTPUT HEADER (FOR PLOT FILE, SEE BELOW)
48 C      -----
49 C
50 C      IF(IOU6.NE.IOU1) WRITE(IOU6,'(''1'')
51 C
52 C      IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
53 C      93 FORMAT( 10X,A50,/,10X,A50,/)
54 C
55 C      WRITE(IOU6,1001)
56 C      1001 FORMAT( 12X,' SUMMARY OF OVERTURNING FORCES AND MOMENTS',//,
57 C                  1          19X,'RADIUS',6X,'TOTF',6X,'TOTM',//,
58 C                  2          20X,'(FT)',7X,'(LB)',5X,'(FT-LB)',//)
59 C      33 CONTINUE
60 C
61 C      -----
62 C      WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER
63 C      -----

```

## SUBROUTINE HIPVEL

```

64  C
65  C      IF (IGRAPH.EQ.1) THEN
66  C
67  C      -----
68  C      OPEN GRAPHICS FILE AND WRITE FILE HEADER
69  C      -----
70  C
71  C      OPEN (IOU8,FILE=PTSFIL(4),STATUS='NEW',ERR=2000)
72  C
73  C      WRITE (IOU8,83) COMM(1),COMM(2)
74  C      83 FORMAT( 10X,A50,/,10X,A50,//)
75  C
76  C      WRITE (IOU8,80)
77  C      80 FORMAT( 1X,'TITLE="TWIN ROTOR DAIP DATA"')
78  C
79  C      WRITE (IOU8,81)
80  C      81 FORMAT( 1X,'VARIABLES = DAIP,TOTF,TOTM')
81  C
82  C      WRITE (IOU8,88)
83  C      88 FORMAT( 1X,'ZONE T = "GW = XXXXX LB, WAGL = XX FT",',
84  C      *           ' I=X, F=POINT')
85  C
86  C      ENDIF
87  C
88  C      -----
89  C      BEGIN LOOP INCREMENTING THE RADIAL POINTS AT WHICH
90  C      THE OVERTURNING MOMENT CALCULATIONS ARE MADE
91  C      -----
92  C
93  C      DO 565 K = 1,NHPTS
94  C
95  C      -----
96  C      TF IS INTERACTION PLANE AMPLIFICATION FACTOR
97  C      (SEE NOTE IN IPVEL.FOR FOR VERSION 2.1)
98  C      -----
99  C
100 C      TF = 1.65 - (0.65)*EXP (-0.5*XIP)
101 C
102 C      -----
103 C      GET PARAMETERS AT BASE RADIUS FOR 'BOUNDARY LAYER'
104 C      -----
105 C
106 C      RIPO = SQRT (XIP**2 + YSEP**2)
107 C
108 C      -----
109 C      'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
110 C      OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
111 C      -----
112 C
113 C      CALL PROPRM(H,UMB,RIPO)
114 C
115 C      ZIPB = ZB
116 C      ZIPM = ZM
117 C      ZIPH = ZH
118 C
119 C      RIPM = SQRT (XIP**2 + (YSEP + ZIPM)**2)
120 C
121 C      CALL PROPRM(H,UMB,RIPM)
122 C
123 C      UMM = UM
124 C
125 C      -----
126 C      OUTPUT HEADER

```

## SUBROUTINE HIPVEL

```

127 C -----
128 C
129 C IF(DSET.NE.0.)GOTO 78
130 C
131 C XXIP = RADIUS*XIP
132 C XIPOUT = XXIP + DVO
133 C
134 C IF(IOU6.NE.IOU1) WRITE(IOU6,'("1")')
135 C
136 C IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
137 C
138 C WRITE(IOU6,1000) XIPOUT
139 C 1000 FORMAT( 2X,'TWIN ROTOR INTERACTION PLANE VELOCITY PROFILE',
140 C 1 ' AT DISTANCE = ',F7.1,' FT',//)
141 C
142 C WRITE(IOU6,1002)
143 C 1002 FORMAT( 3X,'HEIGHT',6X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
144 C 1 'MEAN Q',4X,'PEAK Q',/,,
145 C 2 3X,'(FT)',7X,'(FPS)',6X,'(KN)',5X,'(FPS)',6X,'(KN)',5X,
146 C 3 '(PSF)',5X,'(PSF)',/)
147 C 78 CONTINUE
148 C -----
149 C
150 C 'AN' IS ACTUALLY '= 1.0/7.0'
151 C -----
152 C
153 C AJ = 0.142857142
154 C
155 C DELZ = 0.5/RADIUS
156 C NPTS = 12
157 C
158 C DO 500 I = 1,NPTS
159 C
160 C ZIP = DELZ*(I - 1) + (0.25/RADIUS)
161 C
162 C -----
163 C GET MAX WALL JET VELOCITY AT EFFECTIVE RADIUS
164 C -----
165 C
166 C RIP = SQRT(XIP**2 + (YSEP + ZIP)**2)
167 C
168 C CALL PROPRM(H,UMB,RIP)
169 C
170 C VN = UN
171 C VZ = UM
172 C
173 C -----
174 C INTERACTION PLANE 'BOUNDARY LAYER'
175 C
176 C CODE MODIFIED IN MAY 1992 FOR USER SPECIFIED
177 C MINIMUM BOUNDARY LAYER THICKNESS (BDLAYM)
178 C -----
179 C
180 C ZIP1 = BDLAYM
181 C
182 C IF(ZIP.LT.ZIPM.OR.ZIP.LT.ZIP1)THEN
183 C
184 C IF(ZIP1.LT.ZIPM)THEN
185 C
186 C VZ = UMM*(ZIP/ZIPM)**AN
187 C
188 C ELSE
189 C

```

## SUBROUTINE HIPVLL

```

190          VZ = UMM*(ZIP/ZIP1)**AN
191  C
192          ENDIF
193  C
194          ENDIF
195  C
196  C
197  C          DEVELOPED INTERACTION PLANE JET
198  C
199  C
200          VH = TF*VZ*XIP/RIP
201          VV = TF*VZ*(YSEP + ZIP)/RIP
202  C
203          ZZ = ZIP*RADIUS
204  C
205  C
206  C          MEAN HORIZONTAL VELOCITIES AND DYNAMIC PRESSURE
207  C
208  C
209          VHMF = VH*UN
210          VHMK = VHMF/FPSPKN
211  C
212  C
213  C          PEAK VELOCITIES (BOTH FT/SEC AND KNOTS)
214  C
215  C          EQUATION FOR VMFD3I UPDATED FROM 1st TO
216  C          2nd ORDER POLYNOMIAL FOR VERSION 2.1
217  C
218  C
219          VMFD3I = 0.712887 + 0.304369*XIP - 0.018496*XIP*XIP
220  C
221          IF(VMFD3I.LT.1.2) VMFD3I = 1.2
222  C
223          VHPF = VMFD3I*VHMF
224          VHPK = VHPF/FPSPKN
225  C
226  C
227          THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
228          (UPWIND SIDE) 'XWK' TIMES THE AMBIENT WIND VELOCITY TO
229          THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
230  C
231  C
232          XKW = (-0.5*H) + 2.5
233  C
234          IF(X1.W.LT.1.0) XKW = 1.0
235  C
236          WSPD2 = WSPD*XKW
237          VHMK = VHMK + WSPD2
238          VHMF = VHMK*FPSPKN
239          VHPK = VHPK + WSPD2
240          VHPF = VHPK*FPSPKN
241  C
242  C
243  C          DYNAMIC PRESSURE
244  C
245  C
246          QHM = RHOD2*VHMF**2
247          QP(I) = RHOD2*VHPF**2
248  C
249          IF(DSET.NE.0.)GOTO 77
250  C
251  C
252  C          REPORT HORIZONTAL COMPONENTS

```

## SUBROUTINE HIPVEL

```

253  C -----
254  C
255  C      WRITE (IOU6,1003) ZZ,VHMF,VHMK,VHPF,VHPK,QHM,QP(I)
256  1003 FORMAT ( F8.2,2X,6F10.3)
257  77 CONTINUE
258  C
259  500 CONTINUE
260  C
261  IF (DSET.NE.0.) GOTO 520
262  WRITE (IOU1,73)
263  73 FORMAT( )
264  C
265  WRITE (IOU1,'(19X,A,$)')
266  1  ' TYPE <RETURN> TO CONTINUE
267  C
268  READ (IOU1,'(A1)') TEMCHAR
269  C
270  ICD = 0
271  CALL HOMCLS(ICD)
272  IF (IOU6.NE.IOU1) WRITE (IOU6,'(''1'')
273  C
274  IF (IOU6.EQ.6) WRITE (IOU6,93) COMM(1),COMM(2)
275  C
276  WRITE (IOU6,1007) XIPOUT
277  1007 FORMAT( 12X,'TWIN ROTOR FORCE PROFILE AT DISTANCE = ',
278  1      F7.1,' FT',//)
279  WRITE (IOU6,1008)
280  1008 FORMAT( 2X,'HEIGHT',6X,'PEAK Q',6X,'FOVER',7X,'OVERM',7X,
281  1      'TOT F',7X,'TOT M',/,
282  2      3X,'(FT)',8X,'(PSF)',7X,'(LB)',6X,'(FT-LB)',7X,
283  3      '(LB)',6X,'(FT-LB)',//)
284  520 CONTINUE
285  C -----
286  C
287  C      CALL SUBROUTINE TO CALCULATE THE
288  C      FORCES AND MOMENTS ON A HUMAN BEING
289  C -----
290  C
291  CALL MOMENT(NPTS,HUMTYP,TOTF,TOTM)
292  C
293  IF (DSET.EQ.0.) GOTO 545
294  C
295  HH = XIP*RADIUS
296  HHOUT = HH + DX0
297  C
298  WRITE (ICU6,1014) HHOUT,TOTF,TOTM
299  1014 FORMAT( 1X,F8.2,2F10.3)
300  C
301  IF (IGRAPH.EQ.1) THEN
302  C
303  WRITE (IOU8,90) HHOUT,TOTF,TOTM
304  90  FORMAT( 1X,F7.2,1X,F7.2,1X,F8.2)
305  C
306  ENDIF
307  C
308  545 CONTINUE
309  C
310  XIP = XIP + DELH
311  C
312  565 CONTINUE
313  C -----
314  C
315  C      CLOSE AN OPEN GRAPHICS FILE

```

## SUBROUTINE HIPVEL

```
316 C -----
317 C
318 C IF (IGRAPH.EQ.1) THEN
319 C
320 C     CLOSE (IOU8, STATUS='KEEP')
321 C
322 C     ENDIF
323 C
324 C     CALL INKEY
325 C
326 C     GOTO 999
327 C
328 C -----
329 C     THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
330 C     OPEN ERRORS BY RETURNING THE USER TO A MENU
331 C -----
332 C
333 2000 CONTINUE
334 C
335 C     CALL HOMCLS(0)
336 C     WRITE (IOU1,2001)
337 2001 FORMAT( ///,8X,
338 1      ' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',
339 2 ///,8X,'           TYPE <RETURN> TO CONTINUE ',\$)
340 C     READ (IOU1,'(A1)') TEMCHAR
341 C     KEY = 'P'
342 C
343 999 CONTINUE
344 C
345 C     RETURN
346 C     END
347 C
348 C
```

## SUBROUTINE HOMCLS

```
1 C
2 C
3 C      SUBROUTINE HOMCLS (CODE)
4 C
5 C      ****
6 C      SUBROUTINE HOMCLS
7 C
8 C      THIS SUBROUTINE HOMES THE CURSOR AND CLEARS THE TERMINAL
9 C      SCREEN (CODE=0) OR HOMES THE CURSOR ONLY (CODE=1)
10 C      ****
11 C
12 C      COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
13 C
14 C      INTEGER*4 CODE
15 C
16 C      CHARACTER*4 ED
17 C      CHARACTER*1 EED(4)
18 C      EQUIVALENCE (ED,EED(1))
19 C
20 C      CHARACTER*3 EE
21 C      CHARACTER*1 EEE(3)
22 C      EQUIVALENCE (EE,EEE(1))
23 C
24 C      ****
25 C
26 C      IF (CODE.EQ.1) GOTO 20
27 C
28 C      -----
29 C      HOME CURSOR AND CLEAR SCREEN
30 C      ANSI CONTROL SEQUENCE: ED = ESC[2J
31 C      -----
32 C
33 C      EED(1) = CHAR(27)
34 C      EED(2) = CHAR(91)
35 C      EED(3) = CHAR(50)
36 C      EED(4) = CHAR(74)
37 C
38 C      WRITE (IOU1,*) ED
39 C
40 C      20 CONTINUE
41 C
42 C      -----
43 C      HOME CURSOR ONLY
44 C      ANSI CONTROL SEQUENCE: EE = ESC[H
45 C      -----
46 C
47 C      EEE(1) = CHAR(27)
48 C      EEE(2) = CHAR(91)
49 C      EEE(3) = CHAR(72)
50 C
51 C      WRITE (IOU1,*) EE
52 C
53 C      RETURN
54 C      END
55 C
```

## SUBROUTINE HSVTX

```
1 C
2 C
3 C      SUBROUTINE HSVTX(XT,YT,ZT,VX,VY,VZ,GAMMA,RADIUS)
4 C
5 C
6 ****
7 C      SUBROUTINE HSVTX
8 C
9 C      THIS SUBROUTINE DIRECTS THE CALCULATION OF THE INDUCED VELOCITY
10 C      FIELD DUE TO A HORSESHOE VORTEX SYSTEM OF UNIT STRENGTH.  POINT
11 C
12 C      (LEFT = L1, RIGHT = R1) DEFINE THE EXTENT OF THE BOUND PORTION
13 C      OF
14 C      THE HORSESHOE.  THE TRAILERS START AT POINT 1 AND EXTEND
15 C      THROUGH
16 C      POINT 2, AND THEN ON TO POINT 3.  THIS ALLOWS TWO ELEMENTS FOR
17 C      EACH TRAILER SO THAT IT CAN 'BEND' TO ACCOUNT FOR GROUND
18 C      CONTACT.
19 C
20 ****
21 C
22 C      COMMON /CHSVTX/ XL1,YL1,ZL1,XL2,YL2,ZL2,XL3,YL3,ZL3,
23 C      1           XR1,YR1,ZR1,XR2,YR2,ZR2,XR3,YR3,ZR3
24 C      COMMON /CVLINE/ IFI,XA,YA,ZA,XB,YB,ZB,XC,YC,ZC,Q1,Q2,Q3
25 C
26 C
27 ****
28 C
29 C      -----
30 C      AT SPECIFIED (X,Y,Z) TARGET POINT IN VICINITY
31 C      OF ROTOR, CALCULATE THE VECTOR VELOCITY
32 C      -----
33 C
34 C      VX = 0.0
35 C      VY = 0.0
36 C      VZ = 0.0
37 C
38 C      XC = XT
39 C      YC = YT
40 C      ZC = ZT
41 C
42 C      -----
43 C      LEFT TRAILER CONTRIBUTION, POINT 1 TO POINT 2
44 C      -----
45 C
46 C      IFI = 0
47 C      XA = XL1
48 C      YA = YL1
49 C      ZA = ZL1
50 C      XB = XL2
51 C      YB = YL2
52 C      ZB = ZL2
53 C
54 C      CALL VLINE
55 C
56 C      VX = VX - Q1
57 C      VY = VY - Q2
58 C      VZ = VZ - Q3
59 C
60 C      -----
61 C      LEFT TRAILER IMAGE
62 C      -----
63 C
```

## SUBROUTINE HSVTX

```
64      ZA = -ZA
65      ZB = -ZB
66  C
67  C      CALL VLINE
68  C
69      VX = VX + Q1
70      VY = VY + Q2
71      VZ = VZ + Q3
72  C
73  C      -----
74  C      LEFT TRAILER CONTRIBUTION, POINT 2 TO POINT 3
75  C      -----
76  C
77      IFI = 1
78      XA = XL2
79      YA = YL2
80      ZA = ZL2
81      XB = XL3
82      YB = YL3
83      ZB = ZL3
84  C
85  C      CALL VLINE
86  C
87      VX = VX - Q1
88      VY = VY - Q2
89      VZ = VZ - Q3
90  C
91  C      -----
92  C      LEFT TRAILER IMAGE
93  C      -----
94  C
95      ZA = -ZA
96      ZB = -ZB
97  C
98  C      CALL VLINE
99  C
100     VX = VX + Q1
101     VY = VY + Q2
102     VZ = VZ + Q3
103  C
104  C      -----
105  C      SPANWISE VORTEX CONTRIBUTION
106  C      -----
107  C
108     IFI = 0
109     XA = XL1
110     YA = YL1
111     ZA = ZL1
112     XB = XR1
113     YB = YR1
114     ZB = ZR1
115  C
116  C      CALL VLINE
117  C
118     VX = VX + Q1
119     VY = VY + Q2
120     VZ = VZ + Q3
121  C
122  C      -----
123  C      SPANWISE VORTEX IMAGE
124  C      -----
125  C
126     ZA = -ZA
```

## SUBROUTINE HSVTX

```
127      ZB = -ZB
128 C
129      CALL VLINE
130 C
131      VX = VX - Q1
132      VY = VY - Q2
133      VZ = VZ - Q3
134 C
135 C
136 C      RIGHT TRAILER CONTRIBUTION, POINT 1 TO POINT 2
137 C
138 C
139      IFI = 0
140      XA = XR1
141      YA = YR1
142      ZA = ZR1
143      XB = XR2
144      YB = YR2
145      ZB = ZR2
146 C
147      CALL VLINE
148 C
149      VX = VX + Q1
150      VY = VY + Q2
151      VZ = VZ + Q3
152 C
153 C
154 C      RIGHT TRAILER IMAGE
155 C
156 C
157      ZA = -ZA
158      ZB = -ZB
159 C
160      CALL VLINE
161 C
162      VX = VX - Q1
163      VY = VY - Q2
164      VZ = VZ - Q3
165 C
166 C
167 C      RIGHT TRAILER CONTRIBUTION, POINT 2 TO POINT 3
168 C
169 C
170      IFI = 1
171      XA = XR2
172      YA = YR2
173      ZA = ZR2
174      XB = XR3
175      YB = YR3
176      ZB = ZR3
177 C
178      CALL VLINE
179 C
180      VX = VX + Q1
181      VY = VY + Q2
182      VZ = VZ + Q3
183 C
184 C
185 C      RIGHT TRAILER IMAGE
186 C
187 C
188      ZA = -ZA
189      ZB = -ZB
```

SUBROUTINE HSVTX

```
190  C
191  C      CALL VLINE
192  C
193  C      VX = VX - Q1
194  C      VY = VY - Q2
195  C      VZ = VZ - Q3
196  C
197  C      -----
198  C      DIMENSIONALIZE
199  C      -----
200  C
201  C      GDR= GAMMA/RADIUS
202  C      VX = VX*GDR
203  C      VY = VY*GDR
204  C      VZ = VZ*GDR
205  C
206  C      RETURN
207  C      END
208  C
```

## SUBROUTINE HWJVEL

```

1  C
2  C
3  C      SUBROUTINE HWJVEL(H,UN,UMB,RVZ,RADIUS,WSPD,DELH,HMAX,
4  C                           HUMTYP,DXO,BDLAYM)
5  C
6  C      ****
7  C      SUBROUTINE HWJVEL GENERATES THE VELOCITY PROFILE AND
8  C      THE FORCES AND OVERTURNING MOMENTS FOR A HUMAN BEING
9  C      AT A GIVEN RADIUS
10 C      ****
11 C
12 C      CHARACTER*1 ICNT(5)
13 C      CHARACTER*1 TEMCHAR
14 C      CHARACTER*1 KEY,KKEY,HUMTYP
15 C      CHARACTER*12 PTSFIL(4)
16 C      CHARACTER*50 COMM(2)
17 C
18 C      COMMON / CKEY/ KEY,KKEY
19 C      COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
20 C      COMMON /INPUTC/ ICNT,COMM,PTSFIL
21 C      COMMON /PERSON/ QP(12),DSET
22 C      COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
23 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
24 C
25 C      ****
26 C
27 C      ICD = 0
28 C      CALL HOMCLS(ICD)
29 C
30 C      -----
31 C      INPUT FOR DELH AND HMAX COMES FROM INPUTV STATUS MENU
32 C      -----
33 C
34 C      DSET = DELH
35 C
36 C      IF(DSET.EQ.0.) DELH = HMAX
37 C
38 C      DELH = DELH/RADIUS
39 C      HMAX = HMAX/RADIUS
40 C      NHPTS = IFIX((HMAX - RVZ)/DELH) + 1
41 C
42 C      IF(DSET.EQ.0.)GOTO 50
43 C      IF(IOU6.NE.IOU1) WRITE(IOU6,'("1")')
44 C
45 C      IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
46 C      93 FORMAT( 10X,A50,/,10X,A50,/)
47 C
48 C      WRITE(IOU6,1001)
49 C      1001 FORMAT( 12X,' SUMMARY OF OVERTURNING FORCES AND MOMENTS',/,
50 C                  1         19X,'RADIUS',6X,'TOTF',6X,'TOTM',/,
51 C                  2         20X,'(FT)',7X,'(LB)',5X,'(FT-LB)',/)
52 C      50 CONTINUE
53 C
54 C      -----
55 C      WRITE OUT GRAPHICS FILE IF SWITCH IS SET BY USER
56 C      -----
57 C
58 C      IF(IGRAPH.EQ.1)THEN
59 C
60 C      -----
61 C      OPEN GRAPHICS FILE AND WRITE FILE HEADER
62 C      -----
63 C

```

## SUBROUTINE HWJVEL

```

64      OPEN( IOU8, FILE=PTSFIL(3), STATUS='NEW', ERR=2000)
65  C
66      WRITE( IOU8, 83) COMM(1), COMM(2)
67  83 FORMAT( 10X,A50,/,10X,A50,/)
68  C
69      WRITE( IOU8, 80)
70  80 FORMAT( 1X,'TITLE="SINGLE ROTOR DFRC DATA")'
71  C
72      WRITE( IOU8, 81)
73  81 FORMAT( 1X,'VARIABLES = DFRC,TOTF,TOTM')
74  C
75      WRITE( IOU8, 88)
76  88 FORMAT( 1X,'ZONE T = "GW = xxxxx LB, WAGL = xx FT",',
77      *           ' I=x, F=POINT')
78  C
79      ENDIF
80  C
81  C
82  C      -----  
BEGIN LOOP INCREMENTING THE RADIAL POINTS AT WHICH
83  C      THE OVERTURNING MOMENT CALCULATIONS ARE MADE
84  C
85  C
86  DO 565 K = 1,NHPTS
87  C
88  C
89  C      -----  
'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
90  C      OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
91  C
92  C
93  CALL PROPRM(H,UMB,RVZ)
94  C
95  ZETAM = ZM/ZB
96  ZETAH = ZH/ZB
97  C
98  C
99  C      -----  
CALCULATION OF THE NON-DIMENSIONALIZED MINIMUM ALLOWED
100 C      BOUNDARY LAYER THICKNESS SO THAT THE BOUNDARY LAYER CAN
101 C      BE ADJUSTED IF THE ZM POSITION IS PHYSICALLY TOO LOW
102 C      (BDLAYM, IN FEET, COMES FROM A MENU INPUT PARAMETER)
103 C
104 C
105 ZETA1 = BDLAYM/ZB
106 C
107 C
108 C      -----  
BOUNDARY LAYER REGION EXPONENT
109 C      'AN' IS ACTUALLY '= 1.0/7.0'
110 C
111 C
112 AN = 0.142857142
113 C
114 C
115 C      -----  
SHEAR LAYER REGION EXPONENT, TO MEET EDGE CONDITIONS
116 C      (FROM FIGURE 7, USAAVLABS TECHNICAL REPORT 68-52, JULY 1968)
117 C
118 C
119 ALPW = ALOG(1.0 - 1.0/SQRT(2.0))/ALOG((ZH - ZM)/(ZB - ZM))
120 C
121 VN = UN
122 VMN = UM
123 C
124 C
125 C      -----  
PRINT DETAILED REPORT IF DSET = 0.0 INSTEAD OF SIMPLE REPORT
126 C

```

## SUBROUTINE HWJVEL

```

127  C
128  C      IF(DSET.NE.0.)GOTO 78
129  C
130  C      RRVZ = RVZ*RADIUS
131  C      RVZOUT = RRVZ + DX0
132  C
133  C      IF(IOU6.NE.IOU1) WRITE(IOU6,'("1")')
134  C
135  C      IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
136  C
137  C      WRITE(IOU6,1000) RVZOUT
138  1000 FORMAT( 10X,'SINGLE ROTOR VELOCITY PROFILE AT RADIUS = ',
139  1      F7.1,' FT',//)
140  C      WRITE(IOU6,1005)
141  1005 FORMAT( 2X,'HEIGHT',5X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
142  1      'MEAN Q',4X,'PEAK Q',/,,
143  2      3X,'(FT)',5X,'(FPS)',6X,'(KN)',5X,'(FPS)',6X,'(KN)',5X,
144  3      '(PSF)',5X,'(PSF)',//)
145  C      78 CONTINUE
146  C
147  C      -----
148  C      SET UP ABILITY TO CALCULATE AT 0.5 FT.
149  C      INCREMENTS UP THE VELOCITY PROFILE
150  C      -----
151  C
152  C      DELZ = 0.5/RADIUS
153  C      NPTS = 12
154  C
155  C      DO 500 I = 1,NPTS
156  C
157  C      Z = DELZ*(I - 1) + (0.25/RADIUS)
158  C      ZETA = Z/ZB
159  C
160  C      IF(ZETA.LT.ZETAM.OR.ZETA.LT.ZETA1)THEN
161  C
162  C      -----
163  C      Z IS WITHIN BOUNDARY LAYER
164  C
165  C      NOTE THAT THE BOUNDARY LAYER CALCULATIONS NOW USE
166  C      THE MINIMUM THICKNESS PARAMETER AND THE PEAK TO
167  C      MEAN VELOCITY PARAMETER IS THE MAXIMUM VELOCITY
168  C      HEIGHT RATIO (AT ZM). ADDED MAY 1992 FOR V2.1.
169  C
170  C
171  C      VZM = 0.0
172  C
173  C      IF(ZETAM.GT.0.0)THEN
174  C
175  C          VZM = (ZETA/ZETAM)**AN
176  C
177  C          IF(ZETA1.GT.ZETAM)THEN
178  C
179  C              VZM1 = (1.0 - ((ZETA1 - ZETAM)/(1.0 - ZETAM))**ALPW)**2
180  C              VZM = VZM1*(ZETA/ZETA1)**AN
181  C
182  C          ENDIF
183  C
184  C          VMTOPK = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
185  C
186  C          IF(VMTOPK.LT.1.2) VMTOPK = 1.2
187  C
188  C          ENDIF
189  C

```

## SUBROUTINE HWJVEL

```

190      GOTO 400
191  C
192  C      ENDIF
193  C
194  C      -----
195  C      Z IS WITHIN SHEAR LAYER
196  C
197  C      THE PEAK TO MEAN VELOCITY RATIO EQUATIONS ARE
198  C      SUBSTANTIALLY IMPROVED OVER THOSE USED PRIOR TO
199  C      MAY 1992. EQUATIONS ARE NOW USED FOR BOTH THE
200  C      MAXIMUM VELOCITY HEIGHT (ZM) AND THE 1/2 VELOCITY
201  C      HEIGHT (ZH). VALUES BETWEEN ARE INTERPOLATED AND
202  C      VALUES ABOVE ZH USE THE ZH RATIO*(ZETA/ZETAH).
203  C      THESE 2nd ORDER EQUATION SUBSTANTIALLY IMPROVED
204  C      CORRELATION WITH MODEL AND FLIGHT TEST DATA
205  C      DURING THE MAY 1992 EFFORT FOR V2.1.
206  C
207  C
208  C      VZM = 0.0
209  C
210  C      IF (Z.LE.ZB) THEN
211  C
212  C          VZM = (1.0 - ((ZETA - ZETAM)/(1.0 - ZETAM)) **ALPW) **2
213  C
214  C          IF (ZETA.GE.ZETAH) THEN
215  C
216  C              VMTOPK = (1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ)
217  C              1          * (ZETA/ZETAH)
218  C
219  C          IF (VMTOPK.LT.1.2) VMTOPK = 1.2
220  C
221  C          ELSE
222  C
223  C              VMPKMX = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
224  C
225  C              VMPK12 = 1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ
226  C
227  C              FRAC      = (ZETA - ZETAM)/(ZETAH - ZETAM)
228  C
229  C          IF (ZETA1.GT.ZETAM) THEN
230  C
231  C              FRAC      = (ZETA - ZETA1)/(ZETAH - ZETA1)
232  C
233  C          ENDIF
234  C
235  C          VMTOPK = FRAC*VMPK12 + (1.0 - FRAC)*VMPKMX
236  C
237  C          IF (VMTOPK.LT.1.2) VMTOPK = 1.2
238  C
239  C          ENDIF
240  C
241  C      ENDIF
242  C
243  C      400 CONTINUE
244  C
245  C      VZN = VZM*VMN
246  C
247  C      -----
248  C      DIMENSIONAL HEIGHT
249  C      -----
250  C
251  C      ZZ = Z*RADIUS
252  C

```

## SUBROUTINE HWJVEL

```

253 C -----
254 C MEAN VELOCITIES
255 C -----
256 C
257 C VMF = VZN*VN
258 C VMK = VMF/FPSPKN
259 C -----
260 C
261 C PEAK VELOCITIES
262 C -----
263 C
264 C VPF = VMF*VMTOPK
265 C VPK = VPF/FPSPKN
266 C
267 C
268 C THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
269 C (UPWIND SIDE) 'XWK' TIMES THE AMBIENT WIND VELOCITY TO
270 C THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
271 C -----
272 C
273 C XKW = (-0.5*H) + 2.5
274 C
275 C IF (XKW.LT.1.0) XKW = 1.0
276 C
277 C WSPD2 = WSPD*XKW
278 C VMK = VMK + WSPD2
279 C VMF = VMK*FPSPKN
280 C VPK = VPK + WSPD2
281 C VPF = VPK*FPSPKN
282 C
283 C -----
284 C DYNAMIC PRESSURE
285 C -----
286 C
287 C QM = RHOD2*VMF**2
288 C QP(I) = RHOD2*VPF**2
289 C
290 C IF (DSET.NE.0.) GOTO 77
291 C
292 C WRITE (IOU1,1002) ZZ,VMF,VMK,VPF,VPK,QM,QP(I)
293 C 1002 FORMAT (F8.2,6F10.3)
294 C 77 CONTINUE
295 C
296 C 500 CONTINUE
297 C
298 C IF (DSET.NE.0.) GOTO 520
299 C
300 C WRITE (IOU1,73)
301 C 73 FORMAT ( )
302 C
303 C WRITE (IOU1,'(15X,A,$)')
304 C 1 ' TYPE <RETURN> TO CONTINUE '
305 C
306 C READ (IOU1,'(A1)') TEMCHAR
307 C
308 C ICD = 0
309 C CALL HOMCLS(ICD)
310 C IF (IOU6.NE.IOU1) WRITE (IOU6,'(''1'')')
311 C
312 C IF (IOU6.EQ.6) WRITE (IOU6,93) COMM(1),COMM(2)
313 C
314 C WRITE (IOU6,1007) RVZOUT
315 C 1007 FORMAT (12X,'SINGLE ROTOR FORCE PROFILE AT RADIUS = ',

```

## SUBROUTINE HWJVEL

```

316      1      F7.1,' FT',//)
317  C
318      WRITE(1008,1008)
319  1008 FORMAT( 2X,'HEIGHT',6X,'PEAK Q',6X,'FOVER',7X,'OVERM',7X,
320      1      'TOT F',7X,'TOT M',/,,
321      2      3X,'(FT)',8X,'(PSF)',7X,'(LB)',6X,'(FT-LB)',7X,
322      3      '(LB)',6X,'(FT-LB)',/)
323  C
324  520 CONTINUE
325  C
326  C-----+
327  C      CALL SUBROUTINE TO CALCULATE THE
328  C      FORCES AND MOMENTS ON A HUMAN BEING
329  C-----+
330  C
331  CALL MOMENT(NPTB,HUMTYP,TOTF,TOTM)
332  C
333  IF(DSET.EQ.0.)GOTO 545
334  C
335  HH      = RVZ*RADIUS
336  HHOUT = HH + DXO
337  C
338  WRITE(1014,1014) HHOUT,TOTF,TOTM
339  1014 FORMAT( 1X,F8.2,2F10.3)
340  C
341  IF(IGRAPH.EQ.1)THEN
342  C
343  WRITE(90,90) HHOUT,TOTF,TOTM
344  90  FORMAT( 1X,F7.2,1X,F7.2,1X,F8.2)
345  C
346  ENDIF
347  C
348  545 CONTINUE
349  C
350  RVZ = RVZ + DELH
351  C
352  565 CONTINUE
353  C
354  C-----+
355  C      CLOSE AN OPEN GRAPHICS FILE
356  C-----+
357  C
358  IF(IGRAPH.EQ.1)THEN
359  C
360  CLOSE(1008,STATUS='KEEP')
361  C
362  ENDIF
363  C
364  CALL INKEY
365  C
366  GOTO 999
367  C
368  C-----+
369  C      THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
370  C      OPEN ERRORS BY RETURNING THE USER TO A MENU
371  C-----+
372  C
373  2000 CONTINUE
374  C
375  CALL HOMCLS(0)
376  WRITE(1001,2001)
377  2001 FORMAT( ///,8X,
378      1      ' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',

```

## SUBROUTINE HWJVEL

379 2 //,8X,' TYPE <RETURN> TO CONTINUE ',\$,  
380 READ(I0U1,'(A1)') TEMCHAR  
381 KEY = 'P'  
382 C  
383 999 CONTINUE  
384 C  
385 RETURN  
386 END  
387 C  
388

## SUBROUTINE INKEY

```
1 C
2 C
3 C      SUBROUTINE INKEY
4 C
5 C      *****SUBROUTINE INKEY*****
6 C
7 C      *****SUBROUTINE INKEY*****
8 C
9 C      PARAMETER (NUM = 8)
10 C
11 C      CHARACTER*1 KEY, KKEY
12 C      CHARACTER*1 OKLIST (NUM)
13 C
14 C      COMMON / CKEY/ KEY, KKEY
15 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,ICU8,IGRAPH
16 C
17 C      *****SUBROUTINE INKEY*****
18 C
19 C      DATA OKLIST /'C','c','P','p','N','n','X','x'/
20 C
21 C      -----
22 C      INQUIRE, OBTAIN, AND CHECK FOR VALID MENU OPTION
23 C      -----
24 C
25 C      10 CONTINUE
26 C
27 C      WRITE (IOU1,20)
28 C      20 FORMAT( //,7X,' TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE.'
29 C      1      , ' E<X>IT <--> ',\$)
30 C      READ (IOU1,'(A1)') KEY
31 C
32 C      IF (LEGAL(KEY,IOU1,OKLIST,NUM).EQ.1) GOTO 10
33 C
34 C      -----
35 C      CORRECT LOWER CASE LETTERS TO UPPER CASE
36 C      TO USE AS VALID FLAGS IN PARENT SUBROUTINE
37 C      -----
38 C
39 C      IF (KEY.EQ.'c') KEY = 'C'
40 C      IF (KEY.EQ.'p') KEY = 'P'
41 C      IF (KEY.EQ.'n') KEY = 'N'
42 C      IF (KEY.EQ.'x') KEY = 'X'
43 C
44 C      -----
45 C      CLEAR SCREEN AND HOME CURSOR
46 C      -----
47 C
48 C      ICD = 0
49 C      CALL HOMCLS(ICD)
50 C
51 C      RETURN
52 C      END
53 C
```

## SUBROUTINE INPUT

```

1  C
2  C
3  C      SUBROUTINE INPUT
4  C
5  C      ****
6  C      SUBROUTINE INPUT
7  C
8  C      THIS SUBROUTINE PRESENTS THE INPUT STATUS MENU
9  C      AND MANIPULUTES THE DATA FOR PROGRAM USE
10 C      ****
11 C
12 C      PARAMETER(NUM1 = 19)
13 C      PARAMETER(NUM2 = 9)
14 C      PARAMETER(NUM3 = 4)
15 C      PARAMETER(NUM4 = 4)
16 C
17 C      CHARACTER*1 CHDOL
18 C      CHARACTER*1 CENTRY
19 C      CHARACTER*1 OKLST1(NUM1)
20 C      CHARACTER*1 OKLST2(NUM2)
21 C      CHARACTER*1 OKLST3(NUM3)
22 C      CHARACTER*1 OKLST4(NUM4)
23 C      CHARACTER*1 ICNT(5)
24 C
25 C      CHARACTER*12 PTSFIL(4)
26 C
27 C      CHARACTER*50 COMM(2), LENTRY
28 C      CHARACTER*50 PROMPT
29 C
30 C      DIMENSION CONT(9), CONTV(7), CONTX(8)
31 C
32 C      COMMON /INPUTC/ ICNT, COMM, PTSFIL
33 C      COMMON /INPUTD/ CONT, CONTV, CONTX, YBDLAY
34 C      COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
35 C
36 C      ****
37 C
38 C
39 C      SET DATA TO CHECK FOR ILLEGAL DATA INPUT
40 C
41 C
42 C      DATA OKLST1 /' ','A','a','B','b','C','c','D','d',
43 C      1      'E','e','F','f','G','g','H','h','I','i'/
44 C      DATA OKLST2 /' ','A','a','B','b','C','c','D','d'/
45 C      DATA OKLST3 /'V','v','H','h'/
46 C      DATA OKLST4 /'Y','y','N','n'/
47 C
48 C      10 CONTINUE
49 C
50 C
51 C      CLEAR SCREEN AND HOME CURSOR
52 C
53 C
54 C      CALL HOMCLS(0)
55 C      CALL LOCATE(2,1)
56 C
57 C
58 C      WRITE FIRST ENGINEERING DATA MENU
59 C
60 C
61 C      IROTOR = IFIX(CONT(1))
62 C
63 C      WRITE(IOU1,'(24X,A/)') ' ROTWASH USER INPUT DATA MENU'

```

## SUBROUTINE INPUT

```

64  WRITE (IOU1, '(T7,A,T25,A,T51,A,T61,A/)' ) ' CODE',' PARAMETER',
65  1 ' VALUE',' UNITS'
66  WRITE (IOU1, '(8X,A,T50,I5,8X,A)' )
67  1 ' A      NUMBER OF ROTORS (1 OR 2)  ',IROTOR,'-ND'
68  WRITE (IOU1, '(8X,A,T50,F8.1,6X,A)' )
69  1 ' B      HUB TO HUB ROTOR SEPARATION',CONT(2),'FT'
70  WRITE (IOU1, '(8X,A,T50,F8.1,6X,A)' )
71  1 ' C      ROTOR RADIUS           ',CONT(3),'FT'
72  WRITE (IOU1, '(8X,A,T50,F8.1,6X,A)' )
73  1 ' D      GROSS WEIGHT          ',CONT(4),'LB'
74  WRITE (IOU1, '(8X,A,T50,F8.1,6X,A)' )
75  1 ' E      FUSELAGE DOWNLOAD FACTOR ',CONT(5),'PCT'
76  WRITE (IOU1, '(8X,A,T50,F8.1,6X,A)' )
77  1 ' F      ROTOR HEIGHT ABOVE GROUND ',CONT(6),'FT'
78  WRITE (IOU1, '(8X,A,T50,F8.1,6X,A)' )
79  1 ' G      SHAFT TILT ANGLE (<20 DEG) ',CONT(7),'DEG'
80  WRITE (IOU1, '(8X,A,T50,F8.4,6X,A)' )
81  1 ' H      AIR DENSITY RATIO      ',CONT(8),'ND'
82  WRITE (IOU1, '(8X,A,T50,F8.1,6X,A//)' )
83  1 ' I      AMBIENT WIND (-10 TO 10 KT)',CONT(9),'KT'

84 C
85 C -----
86 C      PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
87 C -----
88 C

89 20 WRITE (IOU1, '(8X,A,$)' )
90 1' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE --> '
91 C
92  READ (IOU1, '(A1)' ) CHDOL
93 C
94  IF (LEGAL (CHDOL, IOU1, OKLST1, NUM1) .EQ. 1) GOTO 20
95 C
96  IF (CHDOL.EQ.' ') GOTO 30
97 C
98  IF (CHDOL.EQ.'A'.OR.CHDOL.EQ.'a') THEN
99 C
100    PROMPT = 'ROTORS = '
101    CALL IREAD (IOU1, PROMPT, IROTOR)
102 C
103    IF (IROTOR.LT.1) IROTOR = 1
104    IF (IROTOR.GT.2) IROTOR = 2
105    CONT(1) = FLCAT (IROTOR)
106 C
107    GOTO 10
108 C
109  ENDIF
110 C
111  IF (CHDOL.EQ.'B'.OR.CHDOL.EQ.'b') THEN
112 C
113    PROMPT = 'ROTOR SEPARATION = '
114    CALL FREAD (IOU1, PROMPT, CONT(2), 1.0)
115    GOTO 10
116 C
117  ENDIF
118 C
119  IF (CHDOL.EQ.'C'.OR.CHDOL.EQ.'c') THEN
120 C
121    PROMPT = 'ROTOR RADIUS = '
122    CALL FREAD (IOU1, PROMPT, CONT(3), 1.0)
123    GOTO 10
124 C
125  ENDIF
126 C

```

## SUBROUTINE INPUT

```
127      IF (CHDOL.EQ.'D'.OR.CHDOL.EQ.'d') THEN
128      C
129          PROMPT = 'GROSS WEIGHT = '
130          CALL FREAD (IOU1,PROMPT,CONT(4),1.0)
131          GOTO 10
132      C
133      ENDIF
134      C
135      IF (CHDOL.EQ.'E'.OR.CHDOL.EQ.'e') THEN
136      C
137          PROMPT = 'DOWNLOAD FACTOR = '
138          CALL FREAD (IOU1,PROMPT,CONT(5),1.0)
139          GOTO 10
140      C
141      ENDIF
142      C
143      IF (CHDOL.EQ.'F'.OR.CHDOL.EQ.'f') THEN
144      C
145          PROMPT = 'HEIGHT ABOVE GROUND = '
146          CALL FREAD (IOU1,PROMPT,CONT(6),1.0)
147          GOTO 10
148      C
149      ENDIF
150      C
151      IF (CHDOL.EQ.'G'.OR.CHDOL.EQ.'g') THEN
152      C
153          PROMPT = 'SHAFT TILT = '
154          CALL FREAD (IOU1,PROMPT,CONT(7),1.0)
155      C
156          IF (CONT(7).LT. 0.0) CONT(7) = 0.0
157          IF (CONT(7).GT.20.0) CONT(7) = 20.0
158          GOTO 10
159      C
160      ENDIF
161      C
162      IF (CHDOL.EQ.'H'.OR.CHDOL.EQ.'h') THEN
163      C
164          PROMPT = 'DENSITY RATIO = '
165          CALL FREAD (IOU1,PROMPT,CONT(8),1.0)
166          GOTO 10
167      C
168      ENDIF
169      C
170      IF (CHDOL.EQ.'I'.OR.CHDOL.EQ.'i') THEN
171      C
172          PROMPT = 'WIND VELOCITY = '
173          CALL FREAD (IOU1,PROMPT,CONT(9),1.0)
174      C
175          IF (CONT(9).LT.-10.0) CONT(9) = -10.0
176          IF (CONT(9).GT. 10.0) CONT(9) = 10.0
177          GOTO 10
178      C
179      ENDIF
180      C
181      GOTO 10
182      C
183      30 CONTINUE
184      C
185      -----
186      C      CLEAR SCREEN AND HOME CURSOR
187      C
188      C
189      CALL HOMCLS(0)
```

## SUBROUTINE INPUT

```

190  CALL LOCATE(2,1)
191  C
192  C
193  C      WRITE SECOND ENGINEERING DATA MENU
194  C
195  C
196  WRITE(IOU1,40)
197  40 FORMAT(' ',18X,' ROTWASH PROGRAM LOGIC/COMMENT MENU',//,
198  1      10X,'CODE           PARAMETER           VALUE')
199  C
200  WRITE(IOU1,50) ICONT(1),ICONT(2),COMM(1),COMM(2)
201  50 FORMAT( 12X,'A      ANALYSIS TYPE,    <V> OR <H>',5X,A4,/,,
202  1      12X,'B      GRAPHICS FILE,    <Y> OR <N>',5X,A4,/,,
203  2      15X,'USER INPUT COMMENTS (FOR "PRN" AND "PLT" OUTPUT)',,
204  3      //,17X,'<---           50 SPACES           --->',,
205  4      /,12X,'C',4X,A50,/,,
206  5      12X,'D',4X,A50,/)
207  C
208  C
209  C      PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
210  C
211  C
212  60 WRITE(IOU1,'(8X,A,$)')
213  1' ENTER CODE FOR DATA INPUT OR <RETURN> TO CONTINUE ==> '
214  C
215  READ(IOU1,'(A1)') CHDOL
216  C
217  IF(LEGAL(CHDOL,IOU1,OKLST2,NUM2).EQ.1)GOTO 60
218  C
219  IF(CHDOL.EQ.' ')GOTO 70
220  C
221  C
222  C      CHOOSE VELOCITY OR HAZARD ANALYSIS OPTION
223  C
224  C
225  IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a')THEN
226  C
227  80  CONTINUE
228  C
229  WRITE(IOU1,'(/,35X,A,1X,A2/)') ' ANALYSIS TYPE = ',ICONT(1)
230  WRITE(IOU1,'(40X,A,$)') ' ENTER NEW VALUE ==> '
231  READ(IOU1,'(A1)') CENTRY
232  C
233  IF(LEGAL(CENTRY,IOU1,OKLST3,NUM3).EQ.1)GOTO 80
234  C
235  ICONT(1) = CENTRY
236  IF(ICONT(1).EQ.'v') ICONT(1) = 'V'
237  IF(ICONT(1).EQ.'h') ICONT(1) = 'H'
238  GOTO 30
239  C
240  ENDIF
241  C
242  C
243  C      CHOOSE OUTPUT TO A GRAPHICS FILE OR NOT
244  C
245  C
246  IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b')THEN
247  C
248  90  CONTINUE
249  C
250  WRITE(IOU1,'(/,35X,A,1X,A2/)') ' GRAPHICS FLAG = ',ICONT(2)
251  WRITE(IOU1,'(40X,A,$)') ' ENTER NEW VALUE ==> '
252  READ(IOU1,'(A1)') CENTRY

```

## SUBROUTINE INPUT

```
253 C
254 C      IF (LEGAL(CENTRY,IOU1,OKLST4,NUM4).EQ.1) GOTO 90
255 C
256 C      ICONT(2) = CENTRY
257 C      IF (ICONT(2).EQ.'y') ICONT(2) = 'Y'
258 C      IF (ICONT(2).EQ.'n') ICONT(2) = 'N'
259 C      IF (ICONT(2).EQ.'Y') IGRAPH = 1
260 C      IF (ICONT(2).EQ.'N') IGRAPH = 0
261 C      GOTO 30
262 C
263 C      ENDIF
264 C
265 C      -----
266 C      CHOOSE COMMENT STRINGS FOR OUTPUT DATA
267 C      -----
268 C
269 C      IF (CHDOL.EQ.'C'.OR.CHDOL.EQ.'c') THEN
270 C
271 C          WRITE (IOU1,'(/,5X,A,A50/)') ' COMMENT STRING = ',COMM(1)
272 C          WRITE (IOU1,'(5X,A,$)') ' ENTER STRING --> '
273 C          READ (IOU1,'(A50)') LENTRY
274 C
275 C          COMM(1) = LENTRY
276 C          GOTO 30
277 C
278 C      ENDIF
279 C
280 C      IF (CHDOL.EQ.'D'.OR.CHDOL.EQ.'d') THEN
281 C
282 C          WRITE (IOU1,'(/,5X,A,A50/)') ' COMMENT STRING = ',COMM(2)
283 C          WRITE (IOU1,'(5X,A,$)') ' ENTER STRING --> '
284 C          READ (IOU1,'(A50)') LENTRY
285 C
286 C          COMM(2) = LENTRY
287 C          GOTO 30
288 C
289 C      ENDIF
290 C
291 C      GOTO 30
292 C
293 C      70 CONTINUE
294 C
295 C      RETURN
296 C
297 C      END
```

## SUBROUTINE INPUTV

```

1 C
2 C
3 C      SUBROUTINE INPUTV(FLOW)
4 C
5 C      ****
6 C      SUBROUTINE INPUTV
7 C
8 C      THIS SUBROUTINE PRESENTS THE INPUT STATUS MENU AND MANIPULATES
9 C      DATA FOR THE WALJET AND IPLANE PROGRAM OPTIONS
10 C      ****
11 C
12 C      PARAMETER(NUM = 11)
13 C
14 C      CHARACTER*1 OKLIST(NUM)
15 C      CHARACTER*1 CHDOL, FLOW
16 C      CHARACTER*1 ICNT(5)
17 C      CHARACTER*12 TMPFIL
18 C      CHARACTER*12 PTSFIL(4)
19 C      CHARACTER*50 COMM(2)
20 C      CHARACTER*50 PROMPT
21 C
22 C      DIMENSION CONT(9),CONTV(7),CONTX(8)
23 C
24 C      COMMON /INPUTC/ ICNT,COMM,PTSFIL
25 C      COMMON /INPUTD/ CONT,CONTV,CONTX,YBDLAY
26 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
27 C
28 C      ****
29 C
30 C      DATA OKLIST /' ','A','a','B','b','C','c','D','d','E','e'/
31 C
32 C      -----
33 C      CLEAR SCREEN AND HOME CURSOR
34 C      -----
35 C
36 C      ICD = 0
37 C
38 C      20 CONTINUE
39 C
40 C      CALL HOMCLS(ICD)
41 C      CALL LOCATE(1,1)
42 C
43 C      WRITE(IOU1,12)
44 C      12 FORMAT( 22X,' VELOCITY PROFILE STATUS MENU',///,
45 C      1      10X,'CODE          PARAMETER          VALUE',
46 C      2      3X,'UNITS',/)
47 C
48 C      -----
49 C      PRINT OUT MENU VARIABLES AS BASED ON THE WALL JET
50 C      OPTION OR INTERACTION PLANE OPTION SWITCH SETTING
51 C      -----
52 C
53 C      IF(FLOW.EQ.'W')THEN
54 C
55 C          WRITE(IOU1,14)(CONTV(I),I=1,3),YBDLAY,PTSFIL(1)
56 C
57 C      ELSE
58 C
59 C          WRITE(IOU1,14)(CONTX(I),I=1,3),YBDLAY,PTSFIL(2)
60 C
61 C      ENDIF
62 C
63 C      14 FORMAT( 12X,'A      PROFILE STATION POSITION ',5X,F7.2,

```

## SUBROUTINE INPUTV

```

64      1  4X,'FT',/,          '
65      2  12X,'B      VERTICAL INCREMENT      ',4X,F7.2,4X,'FT',/,,
66      3  12X,'C      MAXIMUM PROFILE HEIGHT  ',4X,F7.2,4X,'FT',//,
67      4  12X,'D      MINIMUM BOUNDARY LAYER
68 HEIGHT',1X,F7.2,4X,'FT',//,
69      5  12X,'E      DATA OUTPUT FILENAME    ',7X,A12,//)
70 C
71 C -----
72 C   PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
73 C -----
74 C
75 10 CONTINUE
76 C
77      WRITE(IOU1,'(8X,A,$)')
78      1 ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE --> '
79 C
80      READ(IOU1,'(A1)') CHDOL
81 C
82      IF(LEGAL(CHDOL,IOU1,OKLIST,NUM).EQ.1)GOTO 10
83 C
84      IF(CHDOL.EQ.' ')GOTO 30
85 C
86      IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a')THEN
87 C
88          PROMPT = 'PROFILE STATION POSITION = '
89          CALL FREAD(IOU1,PROMPT,CONTV(1),1.0)
90 C
91          IF(CONTV(1).LT.0.0) CONTV(1) = 0.0
92          GOTO 20
93 C
94      ENDIF
95 C
96      IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b')THEN
97 C
98          PROMPT = 'VERTICAL INCREMENT = '
99          CALL FREAD(IOU1,PROMPT,CONTV(2),1.0)
100 C
101         IF(CONTV(2).LT.0.0) CONTV(2) = 0.0
102         GOTO 20
103 C
104     ENDIF
105 C
106     IF(CHDOL.EQ.'C'.OR.CHDOL.EQ.'c')THEN
107 C
108         PROMPT = 'MAXIMUM PROFILE HEIGHT = '
109         CALL FREAD(IOU1,PROMPT,CONTV(3),1.0)
110 C
111         IF(CONTV(3).LT.0.0) CONTV(3) = 0.0
112         GOTO 20
113 C
114     ENDIF
115 C
116     IF(CHDOL.EQ.'D'.OR.CHDOL.EQ.'d')THEN
117 C
118         PROMPT = 'MINIMUM BOUNDARY LAYER HEIGHT = '
119         CALL FREAD(IOU1,PROMPT,YBDLAY,1.0)
120 C
121         IF(YBDLAY.LT.0.0) YBDLAY = 0.0
122         GOTO 20
123 C
124     ENDIF
125 C
126 C -----

```

## SUBROUTINE INPUTV

```
127  C  CHOOSE GRAPHICS FILENAME
128  C  -----
129  C
130  C  IF(CHDOL.EQ.'E'.OR.CHDOL.EQ.'e') THEN
131  C
132  C      IF(FLOW.EQ.'W') THEN
133  C          WRITE(IOU1,'(/,25X,A,1X,A12/)')
134  C          1      ' FILENAME = ',PTSFIL(1)
135  C
136  C      ELSE
137  C          WRITE(IOU1,'(/,25X,A,1X,A12/)')
138  C          1      ' FILENAME = ',PTSFIL(2)
139  C      ENDIF
140  C
141  C      WRITE(IOU1,'(20X,A,$)')
142  C      1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) ==> '
143  C
144  C      READ(IOU1,'(A12)') TMPFIL
145  C
146  C      IF(FLOW.EQ.'W') PTSFIL(1) = TMPFIL
147  C      IF(FLOW.EQ.'I') PTSFIL(2) = TMPFIL
148  C      GOTO 20
149  C
150  C      ENDIF
151  C
152  C      GOTO 20
153  C  30 CONTINUE
154  C
155  C      ICD = 0
156  C      CALL HOMCLS(ICD)
157  C
158  C      RETURN
159  C
160  C      END
```

## SUBROUTINE INPUTX

```

1 C
2 C
3 C      SUBROUTINE INPUTX
4 C
5 C      *****
6 C      SUBROUTINE INPUTX PRESENTS THE INPUT STATUS MENU AND
7 C      MANIPULATES DATA FOR PROGRAM USE WITH THE GROUND AND
8 C      DISC VORTEX OPTIONS
9 C      *****
10 C
11 C      PARAMETER (NUM = 15)
12 C
13 C      CHARACTER*1 OKLIST (NUM)
14 C      CHARACTER*1 CHDOL
15 C      CHARACTER*1 ICONT(5)
16 C      CHARACTER*12 PTSFIL(4)
17 C      CHARACTER*50 COMM(2)
18 C      CHARACTER*50 PROMPT
19 C
20 C      DIMENSION CONT(9),CONTV(7),CONTX(8)
21 C
22 C      COMMON /INPUTC/ ICONT,COMM,PTSFIL
23 C      COMMON /INPUTD/ CONT,CONTV,CONTX,YBDLAY
24 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
25 C
26 C      *****
27 C
28 C      DATA OKLIST // ' ', 'A', 'a', 'B', 'b', 'C', 'c', 'D', 'd',
29 C           'E', 'e', 'F', 'f', 'G', 'g' /
30 C
31 C      -----
32 C      CLEAR SCREEN AND HOME CURSOR
33 C      -----
34 C
35 C      ICD = 0
36 C
37 C      20 CONTINUE
38 C
39 C      CALL HOMCLS(ICD)
40 C      CALL LOCATE(1,1)
41 C
42 C      WRITE(IOU1,10)
43 C      10 FORMAT( 18X, ' GROUND/DISK VORTEX INPUT DATA MENU', /,
44 C           1      15X, ' (FOR SINGLE MAIN ROTOR HELICOPTERS ONLY)', ///,
45 C           1      8X, 'CODE          PARAMETER          VALUE',
46 C           2      4X, 'UNITS', /)
47 C
48 C      WRITE(IOU1,11)(CONTX(I),I=1,7)
49 C      11 FORMAT( 10X, 'A          ROTOR TIP SPEED          ', 5X,F8.2,
50 C           1      4X, 'FPS', /,
51 C           2      10X, 'B          NUMBER OF ROTOR BLADES      ', 5X,F8.2,4X,'-ND-', /,
52 C           3      10X, 'C          TRANSLATIONAL SPEED      ', 5X,F8.2,4X,'KTS', /,
53 C           4      10X, 'D          XT POSITION          ', 5X,F8.2,4X,'FT', /,
54 C           5      10X, 'E          YT POSITION          ', 5X,F8.2,4X,'FT', /,
55 C           6      10X, 'F          ZT CALCULATION INCREMENT ', 5X,F8.2,4X,'FT', /,
56 C           7      10X, 'G          MAXIMUM CALCULATION HEIGHT', 5X,F8.2,4X,'FT', ///)
57 C
58 C      -----
59 C      INQUIRE, OBTAIN, AND CHECK FOR VALID MENU OPTION
60 C      -----
61 C
62 C      40 CONTINUE
63 C

```

## SUBROUTINE INPUTX

```
64      WRITE(IOU1,'(8X,A,$)')
65      1 ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> '
66      C
67      READ(IOU1,'(A1)') CHDOL
68      C
69      IF(LEGAL(CHDOL,IOU1,OKLIST,NUM).EQ.1)GOTO 40
70      C
71      IF(CHDOL.EQ.' ')GOTO 30
72      C
73      IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a')THEN
74      C
75          PROMPT = 'ROTOR TIP SPEED = '
76          CALL FREAD(IOU1,PROMPT,CONTX(1),1.0)
77      C
78          IF(CONTX(1).LT.0.0) CONTX(1) = 0.0
79          GOTO 20
80      C
81      ENDIF
82      C
83      IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b')THEN
84      C
85          PROMPT = 'NUMBER OF ROTOR BLADES = '
86          CALL FREAD(IOU1,PROMPT,CONTX(2),1.0)
87      C
88          IF(CONTX(2).LT.2.0) CONTX(2) = 2.0
89          GOTO 20
90      C
91      ENDIF
92      C
93      IF(CHDOL.EQ.'C'.OR.CHDOL.EQ.'c')THEN
94      C
95          PROMPT = 'TRANSLATIONAL SPEED = '
96          CALL FREAD(IOU1,PROMPT,CONTX(3),1.0)
97      C
98          IF(CONTX(3).LT.0.0) CONTX(3) = 0.0
99          GOTO 20
100     C
101     ENDIF
102     C
103     IF(CHDOL.EQ.'D'.OR.CHDOL.EQ.'d')THEN
104     C
105         PROMPT = 'XT POSITION = '
106         CALL FREAD(IOU1,PROMPT,CONTX(4),1.0)
107         GOTO 20
108     C
109     ENDIF
110     C
111     IF(CHDOL.EQ.'E'.OR.CHDOL.EQ.'e')THEN
112     C
113         PROMPT = 'YT POSITION = '
114         CALL FREAD(IOU1,PROMPT,CONTX(5),1.0)
115         GOTO 20
116     C
117     ENDIF
118     C
119     IF(CHDOL.EQ.'F'.OR.CHDOL.EQ.'f')THEN
120     C
121         PROMPT = 'ZT CALCULATION INCREMENT = '
122         CALL FREAD(IOU1,PROMPT,CONTX(6),1.0)
123     C
124         IF(CONTX(6).LT.0.0) CONTX(6) = 0.0
125         GOTO 20
126     C
```

SUBROUTINE INPUTX

```
127      ENDIF
128  C
129  IF (CHDOL.EQ.'G'.OR.CHDOL.EQ.'g') THEN
130  C
131      PROMPT = 'MAXIMUM CALCULATION HEIGHT = '
132      CALL FREAD (IOU1,PROMPT,CONTX(7),1.0)
133  C
134      IF (CONTX(7).LT.0.0) CONTX(7) = 0.0
135      GOTO 20
136  C
137      ENDIF
138  C
139      GOTO 20
140  C
141 30 CONTINUE
142  C
143      ICD = 0
144      CALL HOMCLS(ICD)
145  C
146      RETURN
147      END
148  C
149
```

SUBROUTINE IOFNSH

```
1 C
2 C
3 C      SUBROUTINE IOFNSH
4 C
5 C      *****SUBROUTINE IOFNSH CLOSES FILES OPENED FOR DISK I/O*****
6 C
7 C
8 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
9 C
10 C      ****
11 C
12 C
13 C      -----
14 C      KEEP STANDARD I/O FILES IF ON DISK, ELSE DELETE
15 C      -----
16 C
17 C      IF (IOU5.EQ.5) CLOSE(IOU5,STATUS='KEEP')
18 C      IF (IOU6.EQ.6) CLOSE(IOU6,STATUS='KEEP')
19 C
20 C      RETURN
21 C      END
22 C
```

## SUBROUTINE IOINIT

```
1 C
2 C
3 C      SUBROUTINE IOINIT
4 C
5 C      ****
6 C      SUBROUTINE IOINIT DISPLAYS THE OPENING BANNER
7 C      AND OPENS THE FILES FOR DISK I/O, FILENAMES
8 C      ARE PROMPTED FROM THE TERMINAL
9 C      ****
10 C
11 C      CHARACTER*3 IPFILE,OPFILE
12 C      CHARACTER*1 TEMCHAR
13 C
14 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
15 C
16 C      ****
17 C
18 C      -----
19 C      ASSIGN DEFAULT VALUES TO I/O UNIT POINTERS
20 C      -----
21 C
22 C      IOU1 = 0
23 C      IOU4 = 0
24 C      IOU5 = 0
25 C      IOU6 = 6
26 C      IOU7 = 0
27 C      IOU8 = 8
28 C      IGRAPH = 0
29 C
30 C      -----
31 C      HOME CURSOR AND CLEAR THE DISPLAY
32 C      -----
33 C
34 C      ICD = 0
35 C      CALL HOMCLS(ICD)
36 C
37 C      -----
38 C      DISPLAY BANNER
39 C      -----
40 C
41 C      CALL LOCATE(5,1)
42 C
43 C      -----
44 C      ORIGINAL ROTHAZ PROGRAM WAS VERSION 1.0
45 C      FIRST VAX MENU VERSION OF ROTHAZ WAS VERSION 1.1
46 C      PROGRAM ROTWASH REPLACES ROTHAZ AT VERSION 2.0
47 C
48 C
49 C      WRITE(IOU1,10)
50 10 FORMAT( 27X,'ROTWASH PROGRAM',//,
51 1 /,17X,'ROTORCRAFT DOWNWASH HAZARD ANALYSIS',//,
52 2 /,18X,'EMA / SYSTEMS CONTROL TECHNOLOGY',//,
53 3 /,15X,'*** PROGRAM VERSION 2.1, APRIL 1993 ***',
54 4 //////////////////////////////////////////////////////////////////)
55 C
56 C      WRITE(IOU1,'(A,$)')
57 1 '                                PRESS <RETURN>
58 C      READ(IOU1,'(A1)') TEMCHAR
59 C
60 C      -----
61 C      HOME CUPSOR AND CLEAR THE DISPLAY
62 C      -----
63 C
```

## SUBROUTINE IOINIT

```

64      ICD = 0
65      CALL HOMCLS(ICD)
66      CALL LOCATE(3,1)
67      C -----
68      C -----
69      C PROMPT FOR I/O FILES AND READ USER RESPONSE
70      C -----
71      C
72      WRITE(IOU1,12)
73      12 FORMAT( 14X,' I/O CAN BE DIRECTED TO FILES OR DEVICES',//,
74      1      19X,' VALID DEVICES ARE AS FOLLOWS:',//,
75      2      22X,' <CON> ==> CONSOLE',/,
76      2      22X,' <PRN> ==> PRINTER',/,
77      4      22X,' <PLT> ==> GRAPHICS FILE',//)
78      C
79      16 CONTINUE
80      C
81      WRITE(IOU1,13)
82      13 FORMAT( 16X,' ENTER INPUT FILE/DEV NAME --> ',$)
83      11 FORMAT(A)
84      READ(IOU1,11) IPFILE
85      C -----
86      C -----
87      C CHECK FOR DATA ENTRY ERROR
88      C -----
89      C
90      IF(IPFILE.NE.'CON'.AND.IFILE.NE.'con')THEN
91      WRITE(IOU1,15)
92      15 FORMAT(/,16X,' ** INPUT ERROR, PLEASE REENTER **',//)
93      GOTO 16
94      ENDIF
95      C
96      17 CONTINUE
97      C
98      WRITE(IOU1,14)
99      14 FORMAT( 16X,' ENTER OUTPUT FILE/DEV NAME --> ',$)
100     READ(IOU1,11) OFFILE
101     C -----
102     C -----
103     C CHECK FOR DATA ENTRY ERROR
104     C -----
105     C
106     IF(OPFILE.NE.'CON'.AND.OPFILE.NE.'con'.AND.
107     1      OFFILE.NE.'PRN'.AND.OPFILE.NE.'prn'.AND.
108     2      OFFILE.NE.'PLT'.AND.OPFILE.NE.'plt')THEN
109     WRITE(IOU1,15)
110     GOTO 17
111     ENDIF
112     C -----
113     C -----
114     C REDIRECT INPUT/OUTPUT FILES IF REQUESTED
115     C -----
116     C
117     IF(IPFILE.EQ.'CON'.OR.IFILE.EQ.'con')IOU5 = IOU1
118     IF(OPFILE.EQ.'CON'.OR.OPFILE.EQ.'con')IOU6 = IOU1
119     IF(OPFILE.EQ.'PRN'.OR.OPFILE.EQ.'prn')IOU6 = 6
120     C
121     IF(OPFILE.EQ.'PLT'.OR.OPFILE.EQ.'plt')IGRAPH = 1
122     IF(OPFILE.EQ.'PLT'.OR.OPFILE.EQ.'plt')IOU6 = IOU1
123     IF(OPFILE.EQ.'PLT'.OR.OPFILE.EQ.'plt')IOU8 = 8
124     C -----
125     C -----
126     C OPEN STANDARD I/C FILES

```

SUBROUTINE IONINIT

```
127 C
128 C      IOU5 = STD. INPUT
129 C      IOU6 = STD. OUTPUT
130 C
131 C      -----
132 C      IF (IOU5.EQ.5) OPEN (IOU5,FILE=IPFILE,STATUS='OLD')
133 C      IF (IOU6.EQ.6) OPEN (IOU6,FILE=OPFILE,STATUS='NEW')
134 C
135 C      -----
136 C      HOME CURSOR AND CLEAR THE DISPLAY
137 C
138 C
139 C      ICD = 0
140 C      CALL HOMCLS (ICD)
141 C
142 C      RETURN
143 C
144 C
```

## SUBROUTINE IPVEL

```

1 C
2 C
3 C      SUBROUTINE IPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELZ,
4 C                           1 ZMAX,DXO,BDLAYM)
5 C
6 C      ****
7 C      SUBROUTINE IPVEL GENERATES THE VELOCITY PROFILE V(X,Z) AT
8 C      XYZ ALONG THE INTERACTION PLANE FOR THE TWO ROTOR CASE
9 C      ****
10 C
11 C      CHARACTER*1 TEMCHAR
12 C      CHARACTER*1 ICONT(5)
13 C      CHARACTER*1 KEY,KKEY
14 C      CHARACTER*12 PTSFIL(4)
15 C      CHARACTER*50 COMM(2)
16 C
17 C      DIMENSION ZZ(60),VHMF(60),VHMK(60),VHPF(60),VHPK(60),
18 C      1 QHM(60),QHP(60),VVMF(60),VVMK(60),VVPF(60),
19 C      2 VVPK(60),QVM(60),QVP(60)
20 C
21 C      COMMON / CKEY/ KEY,KKEY
22 C      COMMON /CONSTS/ PI,RHO,FPSFKN,RHOD2,URC
23 C      COMMON /INPUTC/ ICONT,COMM,PTSFIL
24 C      COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
25 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
26 C
27 C      ****
28 C
29 C
30 C      -----  
TF IS THE INTERACTION PLANE AMPLIFICATION FACTOR
31 C      (ORIGINALLY DEVELOPED BY M. GEORGE IN USAAVLABS TR 68-52)
32 C
33 C      ORIGINAL EQUATION FOR TF FACTOR WAS:
34 C
35 C      TF = 1.55 - 0.55*EXP(-1.35*XIP)
36 C
37 C      REPLACED WITH MODIFIED EXPRESSION (SEE BELOW) DURING
38 C      CORRELATION EFFORT OF MAY 1992 FOR VERSION 2.1
39 C
40 C
41 C      TF = 1.65 - 0.65*EXP(-0.5*XIP)
42 C
43 C
44 C      -----  
OBTAIN PARAMETERS AT BASE RADIUS FOR THE 'BOUNDARY LAYER'
45 C
46 C
47 C      RIPO = SQRT(XIP**2 + YSEP**2)
48 C
49 C
50 C      -----  
'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
51 C      OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
52 C
53 C
54 C      CALL PROPRM(H,UMB,RIPO)
55 C
56 C      ZIPB = ZB
57 C      ZIPM = ZM
58 C      ZIPH = ZH
59 C
60 C      RIPM = SQRT(XIP**2 + (YSEP + ZIPM)**2)
61 C
62 C      CALL PROFIM(H,UMB,RIPM)
63 C

```

## SUBROUTINE IPVEL

```

64      UMM = UM
65      C
66      C
67      C      ----- INCREMENT AND MAXIMUM HEIGHT ARE DELZ AND ZMAX
68      C      -----
69      C
70      C      NPTS = IFIX(ZMAX/DELZ) + 2
71      C
72      C      IF(NPTS.GT.60) NPTS = 60
73      C
74      C      -----
75      C      DIMENSIONALIZE VELOCITY PROFILE PARAMETERS
76      C      -----
77      C
78      C      XXIF = RADIUS*XIP
79      C      ZZB = ZIPB*RADIUS
80      C      ZZH = ZIPH*RADIUS
81      C      ZZM = ZIPM*RADIUS
82      C
83      C
84      C      ----- OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER
85      C      -----
86      C
87      C      ICD = 0
88      C      CALL HOMCIS(ICD)
89      C
90      C      IF(IOU6.NE.IOU1) WRITE(IOU6,'("1")')
91      C
92      C      IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
93      93 FORMAT( 10X,A50,/,10X,A50,/)
94      C
95      C      XIPOUT = XXIF + DXO
96      C
97      C      WRITE(IOU6,1000) XIPOUT
98      1000 FORMAT( 2X,'TWIN ROTOR INTERACTION PLANE VELOCITY PROFILE',
99      1           ' AT STATION = ',F7.1,' FT',/)
100     C
101     C      WRITE(IOU6,1002)
102     1002 FORMAT( 2X,'HEIGHT',8X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
103     1           'MEAN Q',4X,'PEAK Q',/,
104     2           3X,'(FT)',8X,'(FPS)',6X,'(KN)',5X,'(FPS)',6X,'(KN)',5X,
105     3           '(PSF)',5X,'(PSF)',/)
106     C
107     C      LINES = 0
108     C
109     C
110     C      'AN' IS ACTUALLY '= 1.0/7.0'
111     C
112     C
113     C      AN = 0.142857142
114     C
115     C
116     C      ----- CALCULATE THE VELOCITY PROFILE POINTS FOR OUTPUT
117     C      'NPTS' IS THE NUMBER OF VERTICAL STATION POINTS
118     C
119     C
120     C      DO 500 I = 1,NPTS
121     C
122     C      LINES = LINES + 2
123     C      ZIP = DELZ*FLOAT(I - 1)
124     C
125     C
126     C      ----- GET MAX WALL JET VELOCITY AT EFFECTIVE RADIUS

```

## SUBROUTINE IPVEL

```

127  C -----
128  C
129  C      RIP = SQRT(XIP**2 + (YSEP + ZIP)**2)
130  C
131  C      CALL PROPRM(H,UMB,RIP)
132  C
133  C      VN = UN
134  C      VZ = UM
135  C -----
136  C
137  C      INTERACTION PLANE 'BOUNDARY LAYER'
138  C
139  C      CODE MODIFIED IN MAY 1992 FOR USER SPECIFIED
140  C      MINIMUM BOUNDARY LAYER THICKNESS (BDLAYM)
141  C -----
142  C
143  C      ZIP1 = BDLAYM
144  C
145  C      IF (ZIP.LT.ZIPM.OR.ZIP.LT.ZIP1) THEN
146  C
147  C          IF (ZIP1.LT.ZIPM) THEN
148  C
149  C              VZ = UMM*(ZIP/ZIPM)**AN
150  C
151  C          ELSE
152  C
153  C              VZ = UMM*(ZIP/ZIP1)**AN
154  C
155  C          ENDIF
156  C
157  C      ENDIF
158  C
159  C -----
160  C      DEVELOPED INTERACTION PLANE JET
161  C      CONTAINS BOTH HORIZONTAL AND VERTICAL VELOCITY COMPONENTS
162  C -----
163  C
164  C      VH = TF*VZ*XIP/RIP
165  C      VV = TF*VZ*(YSEP + ZIP)/RIP
166  C
167  C      ZZ(I) = ZIP*RADIUS
168  C
169  C -----
170  C      MEAN VELOCITIES (BOTH FT/SEC AND KNOTS)
171  C -----
172  C
173  C      VHMF(I) = VH*UN
174  C      VVMF(I) = VV*UN
175  C      VHMK(I) = VHMF(I)/FPSPKN
176  C      VVMK(I) = VVMF(I)/FPSPKN
177  C
178  C -----
179  C      PEAK VELOCITIES (BOTH FT/SEC AND KNOTS)
180  C
181  C      EQUATION FOR VMFD3I UPDATED FROM 1st TO
182  C      2nd ORDER POLYNOMIAL FOR VERSION 2.1
183  C -----
184  C
185  C      VMFD3I = 0.712887 + 0.304369*XIP - 0.018496*XIP*XIP
186  C
187  C      IF (VMFD3I.LT.1.2) VMFD3I = 1.2
188  C
189  C      VHPF(I) = VMFD3I*VHMF(I)

```

## SUBROUTINE IPVEL

```

190      VVPF(I) = VMFD3I*VVMF(I)
191      VHPK(I) = VHPF(I)/FPSPKN
192      VVPK(I) = VVPF(I)/FPSPKN
193      C
194      IF (VHMF(I).EQ.0.) GOTO 55
195      C
196      -----
197      C      THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
198      C      (UPWIND SIDE) 'XKW' TIMES THE AMBIENT WIND VELOCITY TO
199      C      THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
200      C
201      C
202      XKW = (-0.5*H) + 2.5
203      C
204      IF (XKW.LT.1.0) XKW = 1.0
205      C
206      WSPD2 = WSPD*XKW
207      VHMK(I) = VHMK(I) + WSPD2
208      VHMF(I) = VHMK(I)*FPSPKN
209      VHPK(I) = VHPK(I) + WSPD2
210      VHPF(I) = VHPK(I)*FPSPKN
211      C
212      55  CONTINUE
213      C
214      -----
215      C      DYNAMIC PRESSURES
216      C
217      C
218      QHM(I) = RHOD2*VHMF(I)**2
219      QVM(I) = RHOD2*VVMF(I)**2
220      QHP(I) = RHOD2*VHPF(I)**2
221      QVP(I) = RHOD2*VVPF(I)**2
222      C
223      IF (IOU6.EQ.IOU1) THEN
224      C
225          IF (LINES.LT.12) GOTO 450
226          LINES = 2
227          CALL INKEY
228          IF (KEY.NE.'C') GOTO 999
229          WRITE (IOU6,1002)
230      C
231      ENDIF
232      C
233      450  CONTINUE
234      C
235      -----
236      C      REPORT HORIZONTAL COMPONENTS OF VELOCITY PROFILE
237      C
238      C
239      WRITE (IOU6,1003) ZZ(I),VHMF(I),VHMK(I),VHPF(I),
240      *                      VHPK(I),QHM(I),QHP(I)
241      1003  FORMAT ( F8.2,2X,'H',6F10.3)
242      C
243      -----
244      C      REPORT VERTICAL COMPONENTS OF VELOCITY PROFILE
245      C
246      C
247      WRITE (IOU6,1004) VVMF(I),VVMK(I),VVPF(I),VVPK(I),
248      *                      QVM(I),QVP(I)
249      1004  FORMAT ( 10X,'V',6F10.3)
250      C
251      500 CONTINUE
252      C

```

## SUBROUTINE IPVEL

```
253 C -----  
254 C WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER  
255 C -----  
256 C  
257 C IF(IGRAPH.EQ.1)THEN  
258 C  
259 C -----  
260 C OPEN GRAPHICS FILE  
261 C -----  
262 C  
263 C OPEN(IOU8,FILE=PTSFIL(2),STATUS='NEW',ERR=2000)  
264 C  
265 C WRITE(IOU8,89) COMM(1),COMM(2)  
266 C 89 FORMAT( 10X,A50,/,10X,A50,//)  
267 C  
268 C WRITE(IOU8,80) XIPOUT  
269 C 80 FORMAT( 1X,'TITLE="VELOCITY PROFILE, DAIP =',F5.1,' FT,'  
270 C * ' GW = XXXXX LB, WAGL = XX.X FT"')  
271 C  
272 C -----  
273 C PRINT OUT MEAN VELOCITY, PEAK VELOCITY, AND PEAK  
274 C DYNAMIC PRESSURE PROFILES VERSUS PROFILE HEIGHT (AGL)  
275 C -----  
276 C  
277 C WRITE(IOU8,88)  
278 C 88 FORMAT( 1X,'VARIABLES = X,HT')  
279 C  
280 C WRITE(IOU8,81)  
281 C 81 FORMAT( 1X,'ZONE T = "MEAN PROFILE, KTS", I=xx, F=POINT')  
282 C DO 82 I = 1,NPTS  
283 C WRITE(IOU8,83) VHMK(I),ZZ(I)  
284 C 83 FORMAT( 1X,F6.1,1X,F6.2)  
285 C 82 CONTINUE  
286 C  
287 C WRITE(IOU8,84)  
288 C 84 FORMAT( 1X,'ZONE T = "PEAK PROFILE, KTS", I=xx, F=POINT')  
289 C DO 85 I = 1,NPTS  
290 C WRITE(IOU8,83) VHPK(I),ZZ(I)  
291 C 85 CONTINUE  
292 C  
293 C WRITE(IOU8,86)  
294 C 86 FORMAT( 1X,'ZONE T = "PEAK Q, PSF", I=xx, F=POINT')  
295 C DO 87 I = 1,NPTS  
296 C WRITE(IOU8,83) QHP(I),ZZ(I)  
297 C 87 CONTINUE  
298 C  
299 C -----  
300 C CLOSE GRAPHICS FILE  
301 C -----  
302 C  
303 C CLOSE(IOU8,STATUS='KEEP')  
304 C  
305 C ENDIF  
306 C  
307 C CALL INKEY  
308 C  
309 C GOTO 999  
310 C  
311 C -----  
312 C THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE  
313 C OPEN ERRORS BY RETURNING THE USER TO A MENU  
314 C -----  
315 C
```

SUBROUTINE IPVEL

```
316 2000 CONTINUE
317 C      CALL HOMCLS(0)
318 C      WRITE (IOU1,2001)
319 C      2001 FORMAT( ///,8X,
320 C      1      ' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',
321 C      2      ' //,8X,'           TYPE <RETURN> TO CONTINUE ',$)
322 C      READ (IOU1,'(A1)') TEMCHAR
323 C      KEY = 'P'
324 C      999 CONTINUE
325 C
326 C      RETURN
327 C      END
328 C
329 C      END
330 C
331 C      END
332 C
333 C
```

## SUBROUTINE IREAD

```
1 C
2 C
3 C      SUBROUTINE IREAD(IOU1,PROMPT,IVALUE)
4 C
5 C      ****
6 C      SUBROUTINE IREAD PROMPTS USER FOR AN INTEGER
7 C      DATA ENTRY AND CHECKS VALIDITY OF ENTRY
8 C      ****
9 C
10 C      PARAMETER(LAST=50)
11 C
12 C      CHARACTER*50 PROMPT,SHOWIT
13 C      CHARACTER*15 ENTRY,BLANK
14 C
15 C      DATA BLANK //           '/'
16 C
17 C      ****
18 C
19 C      -----
20 C      PROMPT USER FOR INTEGER ENTRY.  FIND POSITION
21 C      OF LAST NON-BLANK CHARACTER IN PROMPT,
22 C      THEN STORE RIGHT JUSTIFIED IN SHOWIT
23 C      -----
24 C
25 C      N = LAST + 1
26 C
27 C      10 IF(N.EQ.1)GOTO 20
28 C
29 C      N = N - 1
30 C
31 C      IF(PROMPT(N:N).EQ.' ')GOTO 10
32 C
33 C      20 JS = LAST - N
34 C
35 C      WRITE(SHOWIT,'(50A1)') (' ',J=1,JS), (PROMPT(I:I),I=1,N)
36 C
37 C      -----
38 C      NOW ASK USER FOR DATA ENTRY
39 C      -----
40 C
41 C      30 WRITE(IOU1,'(/,1X,A,I3)') SHOWIT,IVALUE
42 C
43 C      WRITE(IOU1,'(/,8X,A,$)')
44 C      1 ' ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS      ==> '
45 C
46 C      READ(IOU1,'(A)') ENTRY
47 C
48 C      IF(ENTRY.EQ.BLANK)RETURN
49 C
50 C      READ(ENTRY,'(BN,I7)',ERR=30) ITEMP
51 C
52 C      IVALUE = ITEMP
53 C
54 C      RETURN
55 C      END
56 C
```

## SUBROUTINE LEGAL

```
1 C
2 C
3 C      FUNCTION LEGAL(CHDOL, IOU1, OKLIST, NUM)
4 C
5 C      *****
6 C      FUNCTION LEGAL DETERMINES IF THE VALUE
7 C      FOR CHDOL IS A VALID INPUT.  THIS VALUE
8 C      IS CHECKED AGAINST THE LIST OF LEGAL
9 C      VALUE IN ARRAY OKLIST(NUM)
10 C      *****
11 C
12 C      CHARACTER*1 CHDOL, OKLIST(NUM)
13 C
14 C      *****
15 C
16 C      LEGAL = 0
17 C
18 C      DO 10 I=1,NUM
19 C      IF(CHDOL.EQ.OKLIST(I)) RETURN
20 C      CONTINUE
21 C
22 C      LEGAL = 1
23 C
24 C      WRITE(IOU1,'(/,T9,A,A1,A/)') ' *** ',CHDOL,
25 C      1 ' IS NOT A VALID INPUT ***'
26 C
27 C      RETURN
28 C      END
29 C
```

## SUBROUTINE LOCATE

```

1  C
2  C
3  C      SUBROUTINE LOCATE (IROW, ICOL)
4  C
5  C      ****
6  C      SUBROUTINE LOCATE LOCATES THE CURSOR POSITION
7  C      ****
8  C
9  C      COMMON / UNITS/ IOU1, IOU4, IOUS, IOU6, IOU7, IOU8, IGRAPH
10 C
11 C      CHARACTER*8 CUP
12 C      CHARACTER*1 ECUP(8)
13 C      EQUIVALENCE (CUP, ECUP(1))
14 C
15 C      CHARACTER*10 FMT
16 C      CHARACTER*1 EFMT(10)
17 C      EQUIVALENCE (FMT, EFMT(1))
18 C
19 C      DATA FMT / '(" ",A7, \)' /
20 C
21 C      ****
22 C
23 C      -----
24 C      ANSI CONTROL SEQUENCE: CUP = ESC['ROW';'COLUMN'H
25 C      -----
26 C
27      IR1 = IROW/10
28      IR2 = IROW - IR1*10
29      IC1 = ICOL/10
30      IC2 = ICOL - IC1*10
31 C
32      ECUP(1) = CHAR(27)
33      ECUP(2) = CHAR(91)
34      IPOS = 3
35 C
36      IF(IR1.GT.0)THEN
37          ECUP(IPOS) = CHAR(IR1 + 48)
38          IPOS = IPOS + 1
39      ENDIF
40 C
41      ECUP(IPOS) = CHAR(IR2 + 48)
42      IPOS = IPOS + 1
43 C
44      ECUP(IPOS) = CHAR(59)
45      IPOS = IPOS + 1
46 C
47      IF(IC1.GT.0)THEN
48          ECUP(IPOS) = CHAR(IC1 + 48)
49          IPOS = IPOS + 1
50      ENDIF
51 C
52      ECUP(IPOS) = CHAR(IC2 + 48)
53      IPOS = IPOS + 1
54 C
55      ECUP(IPOS) = CHAR(72)
56 C
57      EFMT(7) = CHAR(IPOS + 48)
58 C
59      WRITE(IOU1, *) CUP
60 C
61      RETURN
62 C
63 C

```

## SUBROUTINE MOMENT

```
1  C
2  C
3  C      SUBROUTINE MOMENT(NPTS,HUMTYP,TOTF,TOTM)
4  C
5  C      ****
6  C      SUBROUTINE MOMENT CALCULATES THE TOTAL OVERTURNING
7  C      FORCE AND MOMENT ON A MAN OR YOUNG PERSON AND PRINTS
8  C      OUT THE RESULTS.
9  C      ****
10 C
11 CPAX      DIMENSION PAXMAN(12)
12 C      CHARACTER*1 HUMTYP
13 C
14 COMMON /PERSON/ QP(12),DSET
15 COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
16 C
17 C      ****
18 C
19 C      -----
20 C      IN THE SUBROUTINE TO CALCULATE FORCES AND MOMENTS:
21 C
22 C      "CDF" IS THE COEFFICIENT OF DRAG OF THE PERSON:
23 C      CDP = 1.1 FOR HAZARD ANALYSES
24 C      CDP = 1.0 FOR CORRELATION WITH NATC FLIGHT TEST DATA
25 C      "WIDTHP" IS THE WIDTH OF THE PERSON WHERE:
26 C      WIDTHP IS 'L' TYPE IF 1.1 FT
27 C      WIDTHP IS 'S' TYPE IF 0.7 FT
28 C
29 C      -----
30 C      WIDTHP = 1.1
31 C      CDP = 1.1
32 C
33 C      -----
34 C      INITIALIZE AREAS FOR NATC MAN FROM ROTORWASH FLIGHT TESTS
35 C      (UNITS ARE FEET2)
36 C
37 C
38 CPAX      CDP = 1.1
39 CPAX      PAXMAN(1) = 0.41
40 CPAX      PAXMAN(2) = 0.37
41 CPAX      PAXMAN(3) = 0.365
42 CPAX      PAXMAN(4) = 0.42
43 CPAX      PAXMAN(5) = 0.5425
44 CPAX      PAXMAN(6) = 0.685
45 CPAX      PAXMAN(7) = 0.8
46 CPAX      PAXMAN(8) = 0.845
47 CPAX      PAXMAN(9) = 0.7875
48 CPAX      PAXMAN(10) = 0.625
49 CPAX      PAXMAN(11) = 0.3
50 CPAX      PAXMAN(12) = 0.00625
51 C
52 C      -----
53 C      INITIALIZE INTEGRATION STEP SIZE AND ZERO SUMMATION VARIABLES
54 C
55 C
56      DELZZ = 0.5
57      TOTM = 0.0
58      TOTF = 0.0
59 C
60 C      -----
61 C      CHOOSE HUMAN SIZE TYPE
62 C
63 C      -----
```

## SUBROUTINE MOMENT

```
54      IF(HUMTYP.EQ.'S')THEN
55          WIDTHP = 0.7
56          NPTS = 8
57      END IF
58      C
59      -----
60      C      INTEGRATE DYNAMIC PRESSURE PROFILE OVER
61      C      THE HEIGHT OF THE PERSON CHOSEN
62      C      -----
63      C
64      DO 10 J = 1,NPTS
65      C
66      FOVER = QP(J)*DELZZ*WIDTHP*CDP
67      CPAX   FOVER = QP(J)*PAXMAN(J)*CDP
68      ZZ = 0.5*(J - 1) + 0.25
69      OVERM = FOVER*ZZ
70      TOTF = TOTF + FOVER
71      TOTM = TOTM + OVERM
72      C
73      -----
74      C      PRINT OUT RESULTS
75      C      -----
76      C
77      IF(DSET.NE.0.)GOTO 10
78      C
79      WRITE(106,20) ZZ, QP(J),FOVER,OVERM,TOTF,TOTM
80      20 FFORMAT( F9.2,5(2X,F10.3))
81      C
82      10 1000
83      C
84      RETURN
85      END
86      C
87
88
89
90
91
92
93
94
95
96
97
```

## SUBROUTINE PROPRM

```

1 C
2 C
3 C      SUBROUTINE PROPRM(H,UMB,RVZ)
4 C
5 C
6 ****
7 C      SUBROUTINE PROPRM
8 C
9 C      THIS SUBROUTINE CALCULATES THE VELOCITY PROFILE V(R,Z)
10 C      PARAMETERS
11 C      OF THE RADIAL WALL JET FOR THE NON-INTERACTING ROTOR CASE
12 C
13 ****
14 C
15 C      COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
16 C
17 C
18 ****
19 C
20 C      IF(RVZ.GE.RJ)GOTO 600
21 C
22 C      -----
23 C      RVZ .LT. RJ --> TRANSITION REGION
24 C
25 C      TRANSITION REGION EQUATIONS, EMPIRICALLY APPLIED BY
26 C      JDK PRIOR TO VERSION 2.1, WERE SIGNIFICANTLY IMPROVED
27 C      BY THE FOLLOWING CHANGES FOR V2.1 IN MAY 1992.
28 C
29 C      OLD OR REPLACED EQUATIONS:
30 C
31 C      UM = UMJ*RVZ
32 C      IF(RVZ.GT.1.0) UM = UMJ
33 C      ZH = ZHJ*RVZ
34 C      IF(RVZ.GT.1.0) ZH = ZHJ
35 C      ZM = ZMJ*RVZ
36 C      IF(RVZ.GT.1.0) ZM = ZMJ
37 C
38 C      -----
39 C      UM = UMJ* (RVZ/RJ) **0.5
40 C
41 C      -----
42 C      BOUNDARY GROWTH IN TRANSITION REGION
43 C
44 C      SEE NOTE ABOVE
45 C
46 C      OLD OR REPLACED EQUATIONS:
47 C
48 C      ZB0 = 1.5
49 C      IF(H.LT.1.5) ZB0 = H
50 C      ZH = (ZB0 - ZHJ)/RJ**2*(RJ - RVZ)**2 + ZHJ
51 C
52 C      -----
53 C      ZB0 = H**0.5
54 C      ZH0 = ZB0/2.5
55 C
56 C      ZH = (ZH0 - ZHJ)/RJ**2*(RJ - RVZ)**1.5 + ZHJ
57 C      ZB = 2.5*ZH
58 C      ZM = 0.33*ZH
59 C
60 C      GOTO 700
61 C
62 C      -----
63 C      RVZ .GE. RJ --> DEVELOPED WALL JET REGION

```

## SUBROUTINE PROPRM

```
64 C
65 C    SEVERAL COEFFICIENTS IN THE GROWTH EQUATIONS
66 C    WERE MODIFIED IN MAY 1992 FOLLOWING THE
67 C    CORRELATION EFFORT (SEE NOTES IN SUBROUTINE
68 C    WALJET FOR DETAILS).
69 C
70 C    OLD EQUATIONS:
71 C
72 C        UM = CU*RVZ**(-1.143)*UMB
73 C        ZH = CY*RVZ**(1.028)
74 C        ZM = 0.1944*ZH
75 C    -----
76 C
77 C    600 CONTINUE
78 C
79 C        UM = CU*RVZ**(-1.0)*UMB
80 C        ZH = CY*RVZ**(1.0)
81 C        ZB = 2.8*ZH
82 C        ZM = 0.28*ZH
83 C
84 C    700 CONTINUE
85 C
86 C    RETURN
87 C
88 C    END
```

## SUBROUTINE VLINE

```

1 C
2 C
3 C      SUBROUTINE VLINE
4 C
5 C
6 ****
7 C      SUBROUTINE VLINE
8 C
9 C      THIS SUBROUTINE APPLIES THE BIOT-SAVORT LAW TO
10 C      CALCULATE THE VELOCITY INDUCED BY A LINE VORTEX
11 C
12 C      XA,YA,ZA = STARTING POINT OF VORTEX
13 C      XB,YB,ZB = ENDING POINT, OR DIRECTION POINTER
14 C      XC,YC,ZC = TARGET POINT WHERE VELOCITY IS INDUCED
15 C
16 C      IFI = 0      VORTEX IS FINITE, FROM POINT A TO POINT B
17 C      IFI = 1      VORTEX IS SEMI-INFINITE FROM POINT A THROUGH B
18 C
19 C
20 ****
21 C
22 C      COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
23 C      COMMON /CVLINE/ IFI,XA,YA,ZA,XB,YB,ZB,XC,YC,ZC,Q1,Q2,Q3
24 C
25 C
26 ****
27 C
28 C      A = (XA-XC)**2 + (YA-YC)**2 + (ZA-ZC)**2
29 C      B = 2.0*( (XA-XB)*(XC-XA) + (YA-YB)*(YC-YA) + (ZA-ZB)*(ZC-ZA)
30 C      )
31 C      C = (XA-XB)**2 + (YA-YB)**2 + (ZA-ZB)**2
32 C
33 C      C1 = (YC-YB)*ZA + (YA-YC)*ZB + (YB-YA)*ZC
34 C      C2 = (ZC-ZB)*XA + (ZA-ZC)*XB + (ZB-ZA)*XC
35 C      C3 = (XC-XB)*YA + (XA-XC)*YB + (XB-XA)*YC
36 C
37 C      Q = 4.0*A*C - B**2
38 C
39 C      -----
40 C      CHECK FOR COLINEAR TARGET POINT
41 C      -----
42 C
43 C      QB = 0.0
44 C      IF (ABS(Q).LT.1.0E-06) GOTO 100
45 C
46 C      -----
47 C      FINITE LENGTH VORTEX
48 C      -----
49 C
50 C      IF (IFI.EQ.0) THEN
51 C          QB = 1.0/Q*((2.0*C + B)/SQRT(A + B + C) - B/SQRT(A))/2.0/PI
52 C      ENDIF
53 C
54 C      -----
55 C      SEMI-INFINITE VORTEX
56 C      -----
57 C
58 C      IF (IFI.EQ.1) THEN
59 C          QB = 1.0/Q*(2.0*SQRT(C) - B/SQRT(A))/2.0/PI
60 C      ENDIF
61 C
62 C      100 CONTINUE
63 C

```

SUBROUTINE VLINE

```
64 C -----
65 C  VELOCITY COMPONENTS
66 C -----
67 C
68 Q1 = C1*QB
69 Q2 = C2*QB
70 Q3 = C3*QB
71 C
72 RETURN
73 END
74 C
```

## SUBROUTINE WALJET

```

1 C
2 C
3 C      SUBROUTINE WALJET(H,UB,UN,UMB)
4 C
5 C
6 ****
7 C      SUBROUTINE WALJET
8 C
9 C      THIS SUBROUTINE CALCULATES THE STARTING POSITION OF THE
10 C      WALL JET AND GROWTH PARAMETERS FOR WALL JET DECAY
11 C
12 ****
13 C
14 C      COMMON /CLOUDK/ QSMAX
15 C      COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
16 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
17 C
18 C
19 ****
20 C
21 C      -----
22 C      INITIALIZATION OF EXPONENTS
23 C
24 C      CZM, THE PROFILE PEAK VELOCITY LOCATION, WAS INCREASED
25 C      FROM THE GLAUERT VALUE (0.1944) TO THE PRESENT VALUE
26 C      BASED ON DATA AND ASSUMPTIONS PRESENTED IN FAA REPORT
27 C      FOR VERSION 2.1, MAY 1992. THE OTHER COEFFICIENTS WERE
28 C      MODIFIED WHEN IT WAS DEMONSTRATED THAT CORRELATION WAS
29 C      IMPROVED WITH BOTH MODEL AND FLIGHT TEST DATA.
30 C
31 C      VARIABLE      VALUE FOR V2.1      BEFORE V2.1
32 C
33 C      EXU          -1.0          -1.143
34 C      EXY          1.0           1.028
35 C      CZM          0.28          0.1944
36 C      QSMAX0       1.077         1.0 (SEE NOTE BELOW)
37 C
38 C      -----
39 C      EXU = -1.0
40 C      EXY = 1.0
41 C      EXM = 1.0 + EXU + EXY
42 C      CZM = 0.28
43 C      CZB = 2.8
44 C
45 C      -----
46 C      ITERATE TO FIND INITIAL RADIUS OF WALL JET, RJ
47 C
48 C
49 C      TOL = 1.0E-05
50 C      RJ = 2.0
51 C
52 C      QSMAX0 = 1.077
53 C
54 C      DO 100 I=1,20
55 C
56 C      -----
57 C      CALCULATION OF EQUIVALENT JET LENGTH
58 C
59 C
60 C      TR = H + (RJ - 1.0)
61 C      IDE = 0.707*TR
62 C
63 C

```

## SUBROUTINE WALJET

```

64  C  QSMAX CURVEFIT ORIGINALLY TO FIG. 8, USAAVLABS TECHNICAL
65  C  REPORT 68-52, JULY 1968. UPDATED INFORMATION FROM FIG. 2,
66  C  REPORT DTNSRDC/ASED-79/04, APRIL 1979.
67  C
68  C  OLD TR 68-52 EQUATIONS:
69  C
70  C      QSMAX0 = 1.0
71  C      IF (TDE.LE.4.0) QSMAX = QSMAX0 + (0.6 - QSMAX0)/16.0*TDE**2
72  C      IF (TDE.GT.4.0) QSMAX = 2.4/TDE
73  C
74  C  RJNEW COEFFICIENTS ROUNDED OFF DURING MAY 1992 CORRELATION
75  C  EFFORT WHICH PRODUCED IMPROVED RESULTS WHEN SIMPLIFICATIONS
76  C  WERE INTRODUCED
77  C
78  C  OLD EQUATION:
79  C
80  C      RJNEW = 2.508078*(UB/UM)**(0.486)
81  C  -----
82  C
83  C      IF (TDE.LE.3.5) QSMAX = 1.08 - 0.025*TDE**2
84  C      IF (TDE.GT.3.5) QSMAX = 2.7/TDE
85  C
86  C      UM = SQRT(QSMAX)
87  C
88  C      RJNEW = 2.5*(UB/UM)**(0.5)
89  C
90  C      IF (ABS(RJNEW - RJ).LE.TOL) GOTO 200
91  C      RJ = RJNEW
92  C
93  C  100 CONTINUE
94  C
95  C      WRITE (IOU1,10)
96  C  10 FORMAT( '*****',/,
97  C      1      , 'ITERATIONS EXCEEDED FOR WALL JET INITIAL RADIUS',/
98  C      2      , '*****') )
99  C
100 C      STOP ''
101 C
102 C  200 CONTINUE
103 C
104 C      RJ = RJNEW
105 C
106 C  -----
107 C  VELOCITY GROWTH FUNCTION CONSTANTS
108 C
109 C  TWO CONSTANTS WERE ROUNDED OFF TO SIMPLIFY THE FOLLOWING
110 C  TWO EQUATIONS DURING THE CORRELATION EFFORT OF MAY 1992
111 C  FOR VERSION 2.1
112 C
113 C  OLD EQUATIONS:
114 C
115 C      UMB = ((0.3586*RJ**EXM*(UM*UN)*(UB*UN)**(0.14))** (0.88))/UN
116 C      ZHJ = 0.654/(UM/UMB)**2/RJ
117 C
118 C  -----
119 C      UMB = ((0.36*RJ**EXM*(UM*UN)*(UB*UN)**(0.14))** (0.88))/UN
120 C      ZHJ = 0.65/(UM/UMB)**2/RJ
121 C      CU = UM/UMB*RJ**(-EXU)
122 C      CY = ZHJ*RJ**(-EXY)
123 C
124 C  -----
125 C  MAX VELOCITY AND BOUNDARY PARAMETERS AT RJ
126 C

```

SUBROUTINE WALJET

```
127  C
128      UMJ = CU*RJ** (EXU) *UMB
129      ZHJ = CY*RJ** (EXY)
130      ZMJ = CZM*ZHJ
131      ZBJ = CZB*ZHJ
132  C
133      RETURN
134
135  C
```

## SUBROUTINE WJVEL

```

1  C
2  C
3  C      SUBROUTINE WJVEL(H,UN,UMB,RVZ,RADIUS,WSPD,DELZ,ZMAX,DXO,BDLAYM)
4  C
5  C      ****
6  C      SUBROUTINE WJVEL GENERATES THE VELOCITY PROFILE V(R,Z)
7  C      AT RVZ FOR THE NON-INTERACTING ROTOR CASE
8  C      ****
9  C
10 C      CHARACTER*1  TEMCHAR
11 C      CHARACTER*1  ICNT(5)
12 C      CHARACTER*1  KEY,KKEY
13 C      CHARACTER*12 PTSFIL(4)
14 C      CHARACTER*50 COMM(2)
15 C
16 C      DIMENSION ZZ(60),VMF(60),VMK(60),VPF(60),
17 C              VPK(60),QM(60),QP(60)
18 C
19 C      COMMON /  CKEY/ KEY,KKEY
20 C      COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
21 C      COMMON /INPUTC/ ICNT,COMM,PTSFIL
22 C      COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
23 C      COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
24 C
25 C      ****
26 C
27 C      -----
28 C      'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
29 C      OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
30 C      -----
31 C
32 C      CALL PROPRM(H,UMB,RVZ)
33 C
34 C      -----
35 C      DIMENSIONALIZE VELOCITY PROFILE PARAMETERS
36 C      -----
37 C
38 C      RAVZ = RADIUS*RVZ
39 C      ZZB = ZB*RADIUS
40 C      ZZH = ZH*RADIUS
41 C      ZZM = ZM*RADIUS
42 C
43 C      ZETAH = ZH/ZB
44 C      ZETAM = ZM/ZB
45 C
46 C      -----
47 C      OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER
48 C      -----
49 C
50 C      ICD = 0
51 C      CALL HOMCLS(ICD)
52 C      IF(IOU6.NE.IOU1) WRITE(IOU6,'("1")')
53 C
54 C      IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
55 C      93 FORMAT( 10X,A50,/,10X,A50,/)
56 C
57 C      RVZOUT = RRVZ + DXO
58 C
59 C      WRITE(IOU6,1000) RVZOUT
60 C      1000 FORMAT( 9X,'SINGLE ROTOR VELOCITY PROFILE AT RADIUS = ',
61 C                  1   F7.1,' FT',/)
62 C
63 C      WRITE(IOU6,1001) ZZB,ZZH,ZZM

```

## SUBROUTINE WJVEL

```

64 1001 FORMAT( 15X,'PROFILE BOUNDARY HEIGHT = ',F7.2,' FT',/
65 1      ,15X,' HALF-VEL.HEIGHT = ',F7.2,' FT',/
66 2      ,15X,' MAX-VEL HEIGHT = ',F7.2,' FT',/)
67 C
68 C
69 C      INCREMENTS AND HEIGHT ARE FROM DELZ AND ZMAX
70 C
71 C
72 C      NPTS = IFIX(ZMAX/DELZ) + 1
73 C
74 C
75 C      BOUNDARY LAYER REGION EXPONENT
76 C      'AN' IS ACTUALLY = 1.0/7.0
77 C
78 C
79 C      AN = 0.142857142
80 C
81 C
82 C      SHEAR LAYER REGION EXPONENT, TO MEET EDGE CONDITIONS
83 C      (FROM FIGURE 7, USAAVLABS TECHNICAL REPORT 68-52, JULY 1968)
84 C
85 C
86 C      ALPW = ALOG(1.0 - 1.0/SQRT(2.0))/ALOG((ZH - ZM)/(ZB - ZM))
87 C
88 C      VN = UN
89 C      VMN = UM
90 C
91 C
92 C      CALCULATION OF THE NON-DIMENSIONALIZED MINIMUM ALLOWED
93 C      BOUNDARY LAYER THICKNESS SO THAT THE BOUNDARY LAYER CAN
94 C      BE ADJUSTED IF THE ZM POSITION IS PHYSICALLY TOO LOW
95 C      (BDLAYM, IN FEET, COMES FROM A MENU INPUT PARAMETER)
96 C
97 C
98 C      ZETA1 = BDLAYM/ZB
99 C
100 C
101 C      OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER
102 C
103 C
104 C      WRITE(IOU6,1005)
105 1005 FORMAT( 2X,'HEIGHT',5X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
106 1      'MEAN Q',4X,'PEAK Q',/,
107 2      3X,'(FT)',5X,'(FPS)',6X,'(KN)',5X,'(FPS)',6X,'(KN)',5X,
108 3      '(PSF)',5X,'(PSF')//)
109 C
110 C
111 C      CALCULATE THE VELOCITY PROFILE POINTS FOR OUTPUT
112 C
113 C
114 C      LINES = 0
115 C
116 C      DO 500 I = 1,NPTS
117 C
118 C      LINES = LINES + 1
119 C      Z = DELZ*FLOAT(I - 1)
120 C      ZETA = Z/ZB
121 C
122 C      IF (ZETA.LT.ZETAM.OR.ZETA.LT.ZETA1) THEN
123 C
124 C
125 C      Z IS WITHIN BOUNDARY LAYER
126 C

```

## SUBROUTINE WJVEL

```

127 C NOTE THAT THE BOUNDARY LAYER CALCULATIONS NOW USE
128 C THE MINIMUM THICKNESS PARAMETER AND THE PEAK TO
129 C MEAN VELOCITY PARAMETER IS THE MAXIMUM VELOCITY
130 C HEIGHT RATIO (AT ZM). ADDED MAY 1992 FOR V2.1.
131 C -----
132 C
133 C VZM = 0.0
134 C
135 C IF (ZETAM.GT.0.0) THEN
136 C
137 C VZM = (ZETA/ZETAM)**AN
138 C
139 C IF (ZETA1.GT.ZETAM) THEN
140 C
141 C VZM1 = (1.0 - ((ZETA1 - ZETAM) / (1.0 - ZETAM))**ALPW)**2
142 C VZM = VZM1*(ZETA1/ZETA1)**AN
143 C
144 C ENDIF
145 C
146 C VMTOPK = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
147 C
148 C IF (VMTOPK.LT.1.2) VMTOPK = 1.2
149 C
150 C ENDIF
151 C
152 C GOTO 400
153 C
154 C ENDIF
155 C
156 C -----
157 C Z IS WITHIN SHEAR LAYER
158 C
159 C THE PEAK TO MEAN VELOCITY RATIO EQUATIONS ARE
160 C SUBSTANTIALLY IMPROVED OVER THOSE USED PRIOR TO
161 C MAY 1992. EQUATIONS ARE NOW USED FOR BOTH THE
162 C MAXIMUM VELOCITY HEIGHT (ZM) AND THE 1/2 VELOCITY
163 C HEIGHT (ZH). VALUES BETWEEN ARE INTERPOLATED AND
164 C VALUES ABOVE ZH USE THE ZH RATIO* (ZETA/ZETAH).
165 C THESE 2nd ORDER EQUATION SUBSTANTIALLY IMPROVED
166 C CORRELATION WITH MODEL AND FLIGHT TEST DATA
167 C DURING THE MAY 1992 EFFORT FOR V2.1.
168 C -----
169 C
170 C VZM = 0.0
171 C
172 C IF (Z.LE.ZB) THEN
173 C
174 C VZM = (1.0 - ((ZETA - ZETAM) / (1.0 - ZETAM))**ALPW)**2
175 C
176 C IF (ZETA.GE.ZETAH) THEN
177 C
178 C VMTOPK = (1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ)
179 C * (ZETA/ZETAH)
180 C
181 C IF (VMTOPK.LT.1.2) VMTOPK = 1.2
182 C
183 C ELSE
184 C
185 C VMPKMX = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
186 C
187 C VMPK12 = 1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ
188 C
189 C FRAC = (ZETA - ZETAM) / (ZETAH - ZETAM)

```

## SUBROUTINE WJVEL

```

190  C
191  C      IF(ZETA1.GT.ZETAM) THEN
192  C
193  C          FRAC   = (ZETA - ZETA1)/(ZETAH - ZETA1)
194  C
195  C      ENDIF
196  C
197  C      VMTOPK = FRAC*VMPK12 + (1.0 - FRAC)*VMPKMX
198  C
199  C      IF(VMTOPK.LT.1.2) VMTOPK = 1.2
200  C
201  C      ENDIF
202  C
203  C      ENDIF
204  C
205  400  CONTINUE
206  C
207  C      VZN = VZM*VMN
208  C
209  C      -----
210  C      DIMENSIONAL HEIGHT
211  C      -----
212  C
213  C      ZZ(I) = Z*RADIUS
214  C
215  C      -----
216  C      MEAN VELOCITIES
217  C      -----
218  C
219  C      VMF(I) = VZN*VN
220  C      VMK(I) = VMF(I)/FPSPKN
221  C
222  C      -----
223  C      PEAK VELOCITIES
224  C      -----
225  C
226  C      VPF(I) = VMF(I)*VMTOPK
227  C      VPK(I) = VPF(I)/FPSPKN
228  C
229  C      IF(VPK(I).EQ.0.0) GOTO 55
230  C
231  C
232  C      THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
233  C      (UPWIND SIDE) 'XWK' TIMES THE AMBIENT WIND VELOCITY TO
234  C      THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
235  C
236  C
237  C      XKW = (-0.5*H) + 2.5
238  C
239  C      IF(XKW.LT.1.0) XKW = 1.0
240  C
241  C      WSPD2 = WSPD*XKW
242  C      VMK(I) = VMK(I) + WSPD2
243  C      VMF(I) = VMK(I)*FPSPKN
244  C      VPK(I) = VPK(I) + WSPD2
245  C      VPF(I) = VPK(I)*FPSPKN
246  C
247  55   CONTINUE
248  C
249  C      -----
250  C      DYNAMIC PRESSURE
251  C      -----
252  C

```

## SUBROUTINE WJVEL

```

253      QM(I) = RHOD2*VMF(I)**2
254      QP(I) = RHOD2*VPF(I)**2
255      C
256      IF (IOU6.EQ.IOU1) THEN
257          IF (LINES.LT.12) GOTO 450
258          LINES = 1
259          CALL INKEY
260          IF (KEY.NE.'C') GOTO 999
261          WRITE (IOU6,1005)
262          ENDIF
263      C
264      450  CONTINUE
265      C
266      C-----  

267      C-----  

268      C-----  

269      C-----  

270      WRITE (IOU6,1002) ZZ(I),VMF(I),VMK(I),VPF(I),
271      *           VPK(I),QM(I),QP(I)
272      1002  FORMAT( F8.2,6F10.3)
273      C
274      500 CONTINUE
275      C
276      C-----  

277      C-----  

278      C-----  

279      C-----  

280      IF (IGRAPH.EQ.1) THEN
281      C
282      C-----  

283      C-----  

284      C-----  

285      C-----  

286      OPEN (IOU8,FILE=PTSFIL(1),STATUS='NEW',ERR=2000)
287      C
288      WRITE (IOU8,89) COMM(1),COMM(2)
289      89   FORMAT( 10X,A50,/,10X,A50,/)
290      C
291      WRITE (IOU8,80) RVZOUT
292      80   FORMAT( 1X,'TITLE="VELOCITY PROFILE, DFRC =',F5.1,' FT,'
293      *           ' GW = xxxxx LB, WAGL = xx.x FT"' )
294      C
295      C-----  

296      C-----  

297      C-----  

298      C-----  

299      C-----  

300      WRITE (IOU8,88)
301      88   FORMAT( 1X,'VARIABLES = X,HT')
302      C
303      WRITE (IOU8,81)
304      81   FORMAT( 1X,'ZONE T = "MEAN PROFILE, KTS", I=xx, F=POINT')
305      C
306      DO 82 I = 1,NPTS
307      WRITE (IOU8,83) VMK(I),ZZ(I)
308      83   FORMAT( 1X,F6.1,1X,F6.2)
309      82   CONTINUE
310      C
311      WRITE (IOU8,84)
312      84   FORMAT( 1X,'ZONE T = "PEAK PROFILE, KTS", I=xx, F=POINT')
313      C
314      DO 85 I = 1,NPTS
315      WRITE (IOU8,83) VPK(I),ZZ(I)

```

## SUBROUTINE WJVEL

```
316      85  CONTINUE
317  C
318      WRITE( IOU8, 86)
319      86  FORMAT( 1X, 'ZONE T = "PEAK Q, PSF", I=xx, F=POINT' )
320  C
321      DO 87 I = 1,NPTS
322      WRITE( IOU8, 83) QP(I), ZZ(I)
323      87  CONTINUE
324  C
325  C  -----
326  C  CLOSE GRAPHICS FILE
327  C  -----
328  C
329      CLOSE( IOU8, STATUS='KEEP' )
330  C
331      ENDIF
332  C
333      CALL INKEY
334  C
335      GOTO 999
336  C
337  C  -----
338  C  THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
339  C  OPEN ERRORS BY RETURNING THE USER TO A MENU
340  C  -----
341  C
342      2000 CONTINUE
343  C
344      CALL HOMCLS(0)
345      WRITE( IOU1, 2001)
346      2001 FCRMAT( ///,8X,
347      1      ' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME'
348      2      ' //,8X,'           TYPE <RETURN> TO CONTINUE ',S)
349      READ( IOU1, '(A1)' ) TEMCHAR
350      KEY = 'P'
351  C
352      999 CONTINUE
353  C
354      RETURN
355      END
356  C
357
```

*END*